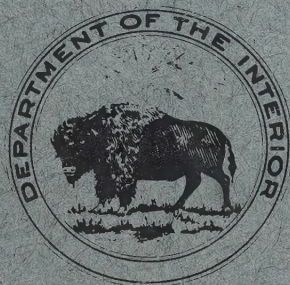


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The PROGRESSIVE FISH-CULTURIST

Vol. 9

No. 4



OCTOBER 1947

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

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The PROGRESSIVE FISH-CULTURIST

News and Views from many Sources on Practical Hatchery Problems

Volume 9

Chicago, Ill.

October 1947

Number 4

FOREIGN INTRODUCTIONS OF NORTH AMERICAN FISHES

INADVISABILITY OF RECOMMENDING NORTH AMERICAN FISHES WITHOUT CAREFUL APPRAISAL OF FOREIGN FISHES AND ECOLOGY

George S. Myers
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Stanford University, California.

THOMAS K. CHAMBERLAIN's article, "There Is No 'Universal' Pondfish," seen in a recent issue of the PROGRESSIVE FISH-CULTURIST, warms my heart. That is the first time I have ever seen a North American fish-culturist state plainly and unequivocally that serious mistakes may be made in recommending North American fishes for introduction into foreign countries. And Chamberlain has pointed out another solid fact: that the statements made by fish-culturists in this country about the value or suitability of our own fishes are frequently but erroneously assumed by foreigners to be applicable to the same species when transferred to other countries. If these two facts alone are understood and remembered by North American fish-culturists, Chamberlain's article will be one of the most valuable ever published in the fish-cultural field.

Most of our professional fish and wildlife men seldom come in contact with foreign specialists or students in the same

line of work, and too many of our men may think the whole matter is of little importance. It so happens, however, that world events have pushed this country into an international leadership--and a world-wide spotlight--a prominence that too few of our citizens (and too few of our fish-culturists) have yet realized. The eyes of many fish-culturists might be opened if they realized the extent of the stream of requests for advice on fishery work, fish culture, and fish introduction which come to the Fish and Wildlife Service from foreign sources and foreign visitors. Almost everything technical done in this country is accepted elsewhere as the best in the world, and anybody who attempts to say the contrary is just not believed--as in Chamberlain's experience with a Chinese visitor.

The writer comes in constant contact with fishery students and visitors from foreign countries. He recently spent 2 years in Brazil, where most of his time

was devoted to fishery and fish-cultural work. He is more or less familiar, personally, with the fisheries in Colombia, Ecuador, and Peru. Since the war Stanford University has had fishery students from Brazil, Mexico, Venezuela, China, and India; and the university has received visitors interested or engaged in fishery work in Peru, Cuba, Brazil, India, Dutch East Indies, French Oceania, Australia, and Russia. Nearly all these men were interested in North American pond-culture methods and in the introduction (generally or for pond-culture) of North American fishes.

It has been very hard to convince some of these men that the introduction of North American fishes into different habitats in foreign countries might be a great mistake. They have heard so much and read so much in our literature about successes with our species that, to many of these visitors, the acme of success is to be obtained merely by the importation of North American species and North American ways of handling. Simply because most of the literature is North American (or European), these foreigners do not know that some Oriental pondfish production equals or exceeds anything we have ever known; and they do not realize that our own fish-culturists often are ignorant of what has been done in other countries.

Most unfortunate of all has been the bad or at least extremely doubtful advice given by our own official fishery agencies (both State and Federal) to foreigners interested in the introduction of North American fishes. That this advice is given in good faith, from long experience, and in a spirit of helpfulness, does not make it any better if the adviser does not know conditions and fishes in the place of introduction. Often the foreigner comes with his mind all made up. He wants this species or that species to take home with him, and it is usually a great deal easier (and more pleasant) to help him to get what he thinks he needs than to sit down and try to find out what sort of ecological conditions he has at home and whether or not he may be making a serious mistake. Indeed, it may be that the foreigner simply has to bring home what he set out for, or lose a great deal of face. Most of us will heartily agree that politics enters into fishery

affairs, and a man who has already made a big noise at home about the wondrous results to be obtained by introducing this or that extraordinary North American fish will often (and correctly) feel that his reputation and his job depend upon bringing home just that fish. But is it good policy always to agree if probable failure is in sight? Let no one think that international relations remain entirely unaffected by even so homely a thing as the failure of an introduced North American fish.

Last year the writer had several long and contentious letters from a Californian, resident in southern Chile but home on a vacation. This Californian wanted to take sunfishes and bass to Chile and had written to Mr. A. C. Taft, Chief of the State Bureau of Fish Conservation, for advice. Taft, knowing of the writer's interest in preventing disastrous foreign introductions of fishes, referred the applicant to the writer. This Californian had heard how wonderful these fishes were, how well they would supplement the rainbow trout already doing well there--a most valuable introduction, by the way. He was determined, in spite of hell and high water, to take sunfishes and bass back and plant them on his hacienda. He had read a great deal about them, and he could not see why there should be any doubt that they were just what was needed. It mattered little that he did not know about certain more northerly Chilean freshwater perches (presumably as well adapted to his waters as sunfishes), or that he could try them first and at far less expense, or that he didn't have any notion as to what these North American fishes would do when put into his trout pond.

On another occasion the writer was told by a member of the Department of Agriculture of Trinidad that his department had approached an agency in the United States for advice on some freshwater, basslike, game fish which might succeed if introduced into the lowland waters of that British West Indian island. Small forage fishes were abundant there, but no larger game species of good food quality was present.

It happens that Trinidad is only a few miles off the delta of the great Orinoco River of Venezuela, which river possesses (among three or four hundred others) two

species of tucunaré, which are good-sized (15 to 20 inches) basslike fishes. They rise to a plug or even a dry fly beautifully, fight hard when hooked, have breeding habits very much like those of our black basses, and have been pond-raised in Brazil. In addition, they are celebrated as the finest food fishes among the 3,000 or more species of fresh-water fishes in South America! Finally, they live under ecological conditions exactly similar to those of the lowland Trinidad streams. After all, they are found within 50 miles of Trinidad!

What did the agency in the United States recommend for introduction into Trinidad? Why, North American largemouth black bass, of course!

Ignorance of what is already available in foreign waters is a serious impediment to the giving of sound advice to foreigners who come to this country for information about fish introductions, but that seldom occurs to North American fish-culturists who are asked. Not only is the man here ignorant of what is easily available there, but the foreigner, as well, may have no idea. Outside of North America and Europe, the native fishes are seldom well known. Often, and especially in tropical countries, the immense fish fauna is next to unknown; and the fisheries officer, working in an office in the capital city, has no idea what kinds of fish inhabit nearby streams, to say nothing of those 50 or 100 miles away. There are no handbooks of the fishes; nobody has ever praised them; and, three times out of five, the fish best appreciated locally comes from a can packed in California or Portugal. But the officer has read of these North American fishes and thinks it would be fine to have them. You can't blame the foreigner for this. That is simply how things are. We must blame the North American fish-culturist who advises crappie or carp without making a serious effort to find out what can be found in the foreigner's own dooryard. A few words with an ichthyologist who has worked in the country in question might produce a useful idea or two.

Another incident about Venezuela comes to mind. About 12 years ago there came to the United States a Venezuelan fishery

officer who was greatly enthused about introducing bluegills into Lake Valencia, in the Venezuelan highlands. Perhaps this was a good idea. The writer has no information to the contrary although he strongly suspects that just as good fishes were already there or that a better fish could have been found nearby. That is not the point of the present story. After considerable fussing about, the agency to which the Venezuelan had come got the "bluegills" for him. What did they do? They went to the Potomac River and seined up the greatest conglomeration of sunfishes you can imagine, and the Venezuelan happily put them into his tanks and sailed away. The writer wonders, if the visitor ever got the fishes to Venezuela alive, just what proportion of the sunfish fauna of the Potomac is now swimming about in Lake Valencia!

Fifteen years ago a great to-do was made in Brazil about the great success to be had with the pond-culture of carp. The man (now deceased) who made the noise was a very good zoologist but had had no practical experience in pondfish culture and (at that time) knew little either of carp or of the tremendous variety of excellent food fishes existing in Brazilian rivers. As a result, carp ponds were pretty generally sprinkled over southeastern Brazil. The result? Few of these carp ponds produced as much as had been expected, and interest subsided except for sporadic outbreaks. In 1944, the writer stood on the banks of the majestic Rio Iguassú at Porto União, watched gigantic schools of carp sweeping along, and heard the laments of the local fishermen, who said that many of the better fishes were becoming incredibly scarce. Nobody wanted carp!

Of course, carp were not intentionally introduced into the Iguassú. Somebody up in the headwaters had some carp ponds, and the inevitable happened: a cloudburst washed some carp into the river. The writer hopes he succeeded, while he was in Para, in convincing the local fishery officer that some new carp ponds near town should be emptied and every carp destroyed. The writer tried very hard. If his arguments were not convincing, we shall soon see the mighty Amazon teeming with carp--to the detriment and sure

decline of the finest array (300 species) of excellent fresh-water food fishes possessed by any river in the world.

In South Africa, largemouth black bass have been a great success. No large, predaceous, basslike fish had existed in these cooler waters of Africa; and the writer is not prepared to say, off-hand, that a better fish could have been found. The success in South Africa has caused great interest in black bass to be exhibited in East Africa. Here, however, conditions--the native fish population and the temperature--are not what they are in South Africa. East Africa is tropical, though mostly dry. Tropical Africa has the finest array of basslike fresh-water fishes found on any continent. Nearly all these fish belong to the same family (Cichlidae) as the fine tucunaré of Venezuela. The great lakes (one is 400 miles long) of Central East Africa have the finest set of species of these basslike Cichlids in the continent of Africa. Yet there are serious proposals to introduce the North American largemouth into the great African lakes--proposals made with no thought of adaptability, of what is already there, of anything. Such is the fame of a successful fish!

Perhaps the writer has said enough--enough; at least, to make readers think twice before pontificating on what North American fishes should be introduced into some foreign country about which the advisers know nothing. The writer sincerely hopes so.

It is impossible to close, however, without saying a word about Chamberlain's suggestion for an international "efficiency rating" of pondfishes. The idea is a good one, and the project should be taken up by some agency. The writer does see difficulties ahead in getting sufficient information on certain foreign pondfishes, but he does not think that non-availability of some of the data would

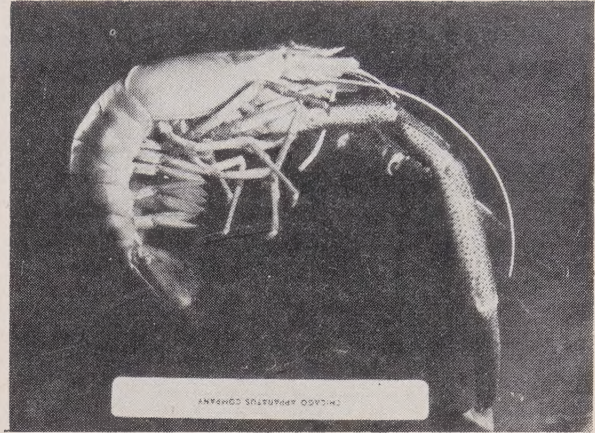
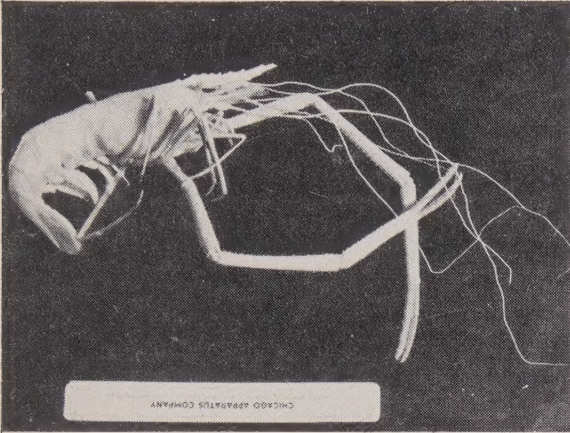
necessarily prevent such a project from being exceedingly useful. The project would merely be less complete than we would like. As far as details go, any attempt to rate fish on flavor, on any international scale, would seem doomed to failure simply because of the very different standards of excellence in different regions. Some sort of rating on other factors could be made, however, and the writer thinks the result would be an eye-opener for North American fish-culturists.

Finally, if an "efficiency rating" of pondfishes can be made, why not a booklet for foreigners on the general subject of fish introduction? Since the Fish and Wildlife Service is the North American agency most frequently approached, it would seem obvious that the Service is the agency to produce the booklet. The ecological and cultural needs of the most common of our fishes could be given very briefly, with a short chapter on the elements of fish ecology as applied to fish introductions and pond culture, plus a series of straight and pertinent questions about his own local conditions and fishes for the would-be introducer to answer for himself before he asks for advice or for live North American fish. Such a brochure would be extremely useful, not only to the Service in its dealings with foreign fishery men, but to those in this country who are contemplating pond culture or introductions. At the end of the booklet, Chamberlain's efficiency table of the world's most important pondfishes would double the value of the booklet.

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1947. There is no 'universal' pondfish.
Prog. Fish-Cult. 9 (2): 78-83.



(Photos by Jack Blackwell, Rockport, Texas)

Macrobrachium acanthurus.

Macrobrachium jamaicense. The feelers have been broken off.

RIVER SHRIMPS

INTERESTING CRUSTACEANS ABOUT WHICH LITTLE HAS BEEN WRITTEN

Joel W. Hedgpeth
Texas Game, Fish and Oyster Commission
Rockport, Texas.

ALTHOUGH LITTLE is known regarding the shrimps that inhabit the fresh waters of southern United States, the large size of several of the species never fails to arouse the interest and curiosity of those who encounter them. One species, common in the Mississippi drainage from Ohio to the Gulf, finds its way into markets, but so far no use has been found for most of these shrimps.

There are four species of river shrimps in North America, all of them members of the genus Macrobrachium (meaning "long-armed"). This genus is a member of the family Palaemonidae, which includes the small, transparent grass or "glass" shrimp of the genus Palaemonetes and several other small fresh-water and marine shrimps

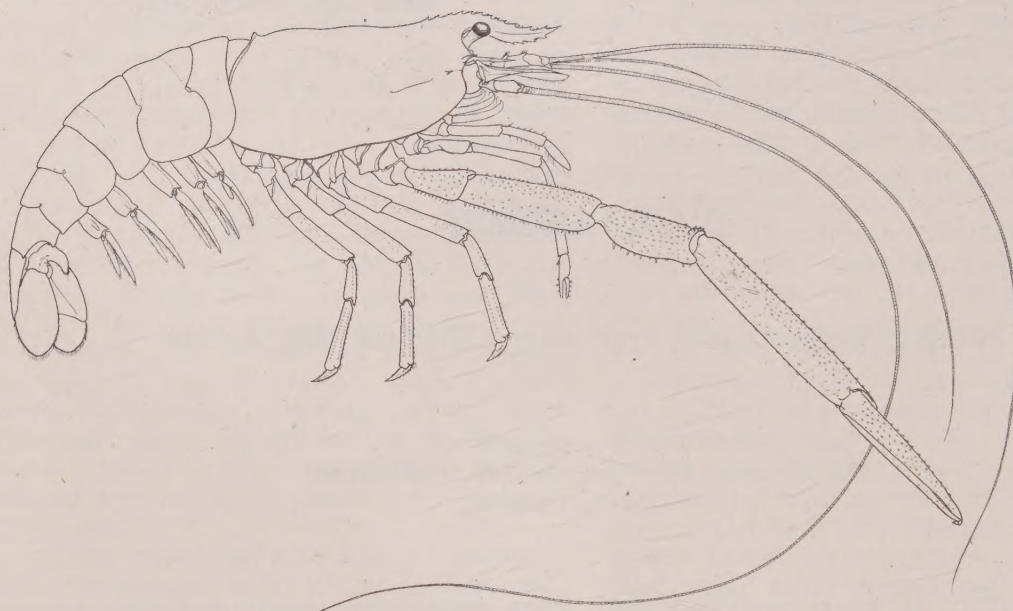
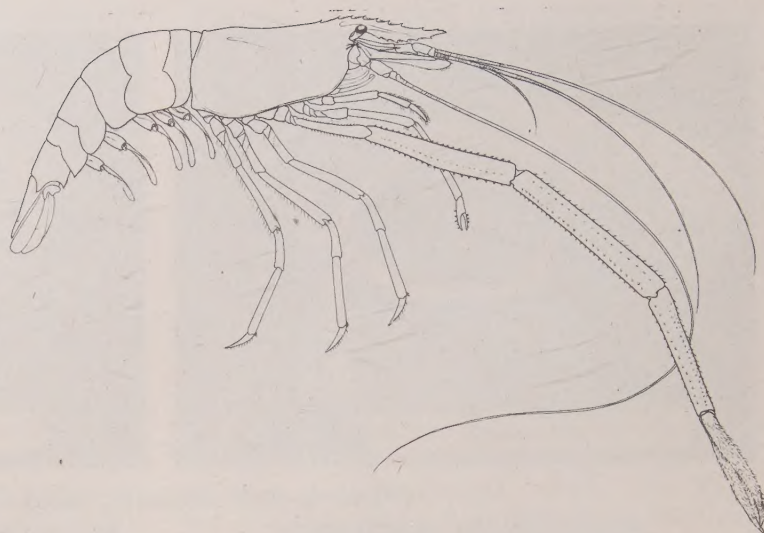
that occur throughout the West Indies as well as in other parts of the world. Grass shrimps are sometimes very abundant in streams and in the fresher parts of bays, and they are undoubtedly an important food item for fish and birds. These fresh- and brackish-water shrimps are more closely related to the well-known commercial shrimp, Peneus setiferus, than to the fresh-water crayfish, but the big river shrimps are sometimes called "crayfish."

The four species of Macrobrachium found in the United States are as follows:

Macrobrachium acanthurus. One of the largest of the river shrimps, this species

Macrobrachium acanthurus.

Macrobrachium jamaicense.

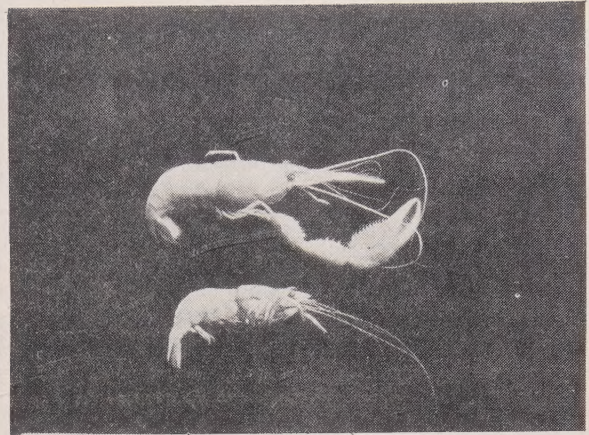
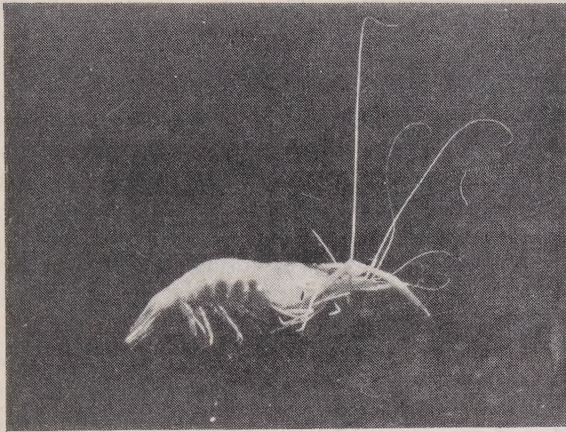


(Drawings courtesy of the author)

can be readily identified because of the very long, slender claws [chelipeds], in which the wrist joint is as long as the claw [chela] itself. The fingers are straight, cylindrical, do not have large teeth, and are covered with a feltlike growth of fine hair. Usually the fingers are covered with mud because of these hairs. In life this creature is olive green--shading to blue along the sides of the abdomen and the tail--and has a brownish-orange stripe along the middle of the back. This species is found from

St. Augustine, Florida, to Brazil. Apparently more common in Texas, this shrimp is found in rivers in the east-central part of that State and in the coastal bays during periods of heavy rainfall, when the salinity is low.

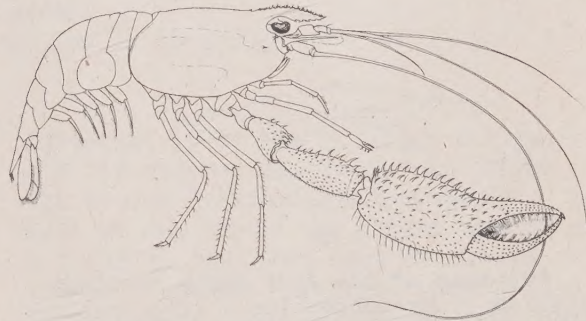
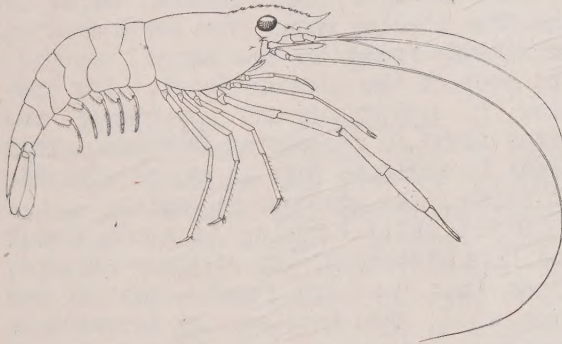
Macrobrachium jamaicense. This is probably the largest species found in North America. Specimens measuring nearly 2 feet from tip of tail to tip of extended claws, are not rare. The claw of this shrimp is large, and the wrist joint is shorter than the chela. Each finger has



(Photos by Jack Blackwell, Rockport, Texas)

Macrobrachium ohionis. A female with eggs.

Macrobrachium olfersii. Male and female.

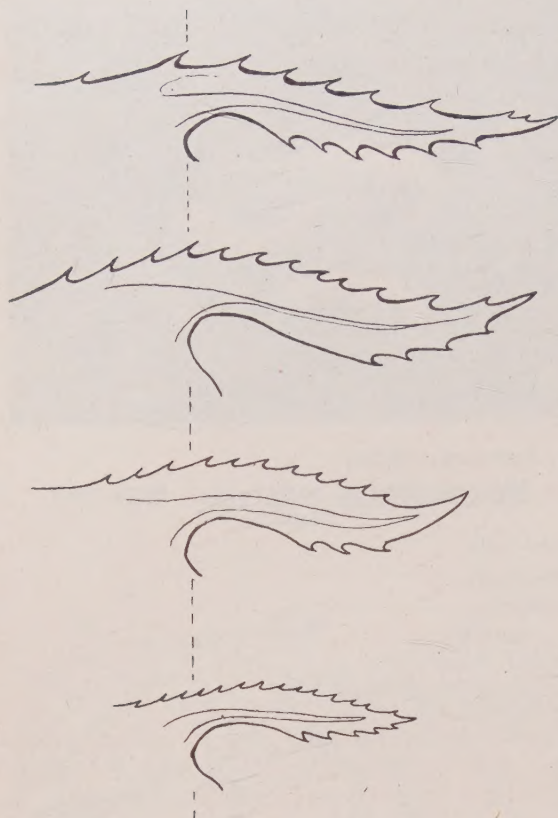


a broad, triangular tooth. The general color of this shrimp is chocolate brown, with cream mottlings on the sides, shading to green at the edges and on the tail. The claws are green, with black tubercles, orange markings at the joints, and an orange stripe along the side. This species is found from Florida to Brazil; in the United States, it occurs especially in the rivers of southern Texas.

Macrobrachium ohionis. This species is usually 6 to 8 inches long. Although considerably smaller than the two preceding species, *M. ohionis* is probably the best-known river shrimp in the United States. Unlike the claws of the other shrimps discussed, the claws of this species are of slightly different size; they are without teeth or hairy covering and are not conspicuously large. This shrimp is gray but has blue spots and flecks on the abdomen and a pale blue tail. This is the species that is occasionally sold

in Louisiana markets. At one time there was a small-scale commercial fishery for this shrimp in Illinois, but that seems to have been abandoned in recent years. This species is found from North Carolina to Texas, and in the Mississippi River from the Gulf to St. Louis.

Macrobrachium olfersii. In the United States, this species is found only at St. Augustine, Florida, although it is widely distributed through the West Indies and Central America. Unlike the other three species, the male and female of this species have different claws. The male has one large, swollen claw, which is armed with tufts of bristles on the fingers and has many large curved spines on the outer edges of the palm and other joints. The other claw is smaller but also has hairy tufts and curved spines. The claws of the female are much smaller and plainer.



Rostrums of the four North American species of Macrobrachium. (Top to bottom: acanthurus, jamaicense, ohionis, and olfersii.)

Probably the best way to tell these four shrimps apart, especially when the claws are missing, is by the structure of the rostrum, the large spine projecting between the eyes. Although the number of teeth on these spines varies somewhat, there is no pronounced intergrading. The differences are plain in the drawing. The most important detail to notice is the number of teeth behind the margin of the eye socket (orbit) and on the lower side of the rostrum.

The fact that these river shrimps often find their way into the bays during the winter may in some way be connected with the turbidity of the rivers at this time. It has been suggested that these shrimps may not be able to withstand such turbidity, although they appear to have a rather wide salinity tolerance.

At St. Augustine, Florida, three of the four species known from North America have been found in the large, spring-fed pool of the Alcazar Hotel. Two species, M. acanthurus and jamaicense, are often found in reservoirs in Texas. This seems to indicate that it may be possible to raise these shrimps in ponds.

Practically nothing is known about the life history of any of these shrimps, other than that the female carries the eggs until, when hatched, the larvae have reached a comparatively late stage of development.

MORE 2,4-D

Continuing his studies of the effects of certain newly developed chemicals on aquatic organisms, E. W. Surber of the U. S. Fish-Cultural Station at Kearneysville, West Virginia, recently reported that three large plots of white water lilies (Nymphaea odorata) near Leesburg, Virginia, had been sprayed with 2,4-D. Three 2,4-D formulas were used. In one plot, a 5-percent 2,4-D solution prepared

from the sodium salt of 2,4-D was used; in the second, a 5-percent solution of 2,4-D with tributylphosphate, a cosolvent, was used; in the third plot, a 5-percent solution of 2,4-D in triethanolamine and water was sprayed. Preliminary observations showed that the tributylphosphate formula was much the easiest to use and that it caused the leaves to curl before completion of the spraying.

SUPPLEMENTING WILD TROUT WITH LEGAL-SIZED HATCHERY
TROUT TO MEET FISHING PRESSURE ON A CONTROLLED AREA

TEN YEARS OF

TROUT STREAM MANAGEMENT ON THE PISGAH

T. K. Chamberlain
Fish and Wildlife Service
College Station, Texas

and
W. W. Huber, District Ranger
Forest Service
Pisgah National Forest, North Carolina.

TEN FULL FISHING seasons have run their course since the start of stream-management research in the Pisgah Ranger District of the Pisgah National Forest in western North Carolina. The more formal experimental period of this study (1937 to 1941, inclusive) was a cooperative project of the Fish and Wildlife Service and the Forest Service (Holloway and Chamberlain, 1941; Chamberlain, 1942, 1943, 1947). During this period certain stream-management principles were developed and put into practice. During the second 5 years (1942 to 1946, inclusive) the management was continued under the general supervision of the Federal agencies named and the North Carolina Department of Conservation and Development.

Immediate direction of stream management was the responsibility of the office of the Forest Service District Ranger. In this second period the stream-management principles that had been developed and adopted, seemed justified under trial. The practices related to these principles were modified somewhat as a result of additional information and the stress of changing conditions.

The goal established during the first period has been kept ever in sight: "The most trout fishing for the most trout fishermen, and an equal opportunity for every angler." This goal has been reached through the application of three principles. The first involves the use of legal-sized hatchery trout to supplement the supply of the large wild trout to meet fishing pressure. The second requires that the fishing drain of each watershed, or group of streams within the managed area, be in proportion to the total fishing capacity of the area as a whole. This is accomplished by opening only one or two watersheds, or groups of streams, at a time, by varying the number of open days for each group according to fishing capacity, and by staggering open dates through the season for these

See also:

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1938. Fish management in the Pisgah National Game Preserve.
Prog. Fish-Cult. 35: 1-9.

----- Chamberlain, T. K.; and Knuth,
R. O.
1939. Report on Pisgah fish management, 1939. Prog. Fish-Cult.
44: 1-10.



A Pisgah brook trout stream.

groups, to spread the fishing to best advantage. The third principle deals with the efficient utilization of the natural supply of trout food in the streams. During the fishing season, when the emerging aquatic insects would normally be lost to the economy of the stream, fish are planted in sufficient quantity so that the food supply just maintains the whole stock of fish. Then for the rest of the year the food supply serves both to maintain and to permit the growth of the surviving legal-sized fish as well as the young.

For those not familiar with the Pisgah trout-stream management area, a brief description may be in order. The area contains the 100,000-acre Pisgah Game Preserve and the 30,000-acre Sherwood Wildlife Area. These two divisions of

the main experimental area contain approximately 150 miles of trout streams, divided into six main watershed groups. The most important single stream (because of popularity resulting from individual attractiveness and ease of access, rather than because of really superior fishing qualities) is the Davidson River. Because of the popularity of the Davidson River, reference is made to it as an example of the Pisgah streams. Including tributaries, the Davidson has about 30 miles of stream. Of this, about 10 miles form the main stream, which has an average width of 47 feet, a depth of 14 inches, and a volume of 35,000 gallons per minute. The bottom is predominantly rubble, but boulders are second in prevalence. Pool grade is about B plus.

The Sherwood section of the experimental area is on the north side of the Pisgah Ridge. These streams have been essentially brook-trout waters throughout the past 10 years and more, though some rainbows are coming in from private waters below. Only brook trout, however, are planted in the Sherwood. In the Pisgah Game Preserve, on the other hand, the main waters have been stocked with rainbow trout for the most part. Brown trout were tried in two streams for several years, but the stocking of this species was discontinued in 1940. Brook trout have been stocked in the small tributaries since the start of the experimental work. Because of the increasing popularity of this species, however, it is now used more extensively in the trunk waters.

At the start of the experimental period in 1937, the plan was to stock all streams with trout in the fall--trout that had been raised to as large a size as possible during the preceding spring and summer. To a large extent, the 39,325 trout that were planted in the fall of 1937 consisted of fish $7\frac{1}{2}$ inches long and in excellent condition. The same was true for the 26,118 trout planted in the fall of 1938. A glance at table 1 shows that the heavy plants of hatchery trout in the fall had little effect on fishing during the following seasons. It was not until trout of legal size had been planted in the spring and had been used as sustaining plants after the fishing had started,

that a marked improvement in fishing became discernible. Comparison with spring-planted legal-sized trout showed that during the 5-year experimental period though the fall-stocked trout were of legal and near-legal size, only a fifth as many (in proportion to the numbers planted) entered the fishermen's creels. Actual recoveries averaged 9 percent for fall-planted trout, the highest recovery from an individual plant being 26 percent. The average recovery for spring-planted trout was more than 47 percent, and recoveries from individual plants ran as high as 82.7 percent. From this it was decided that the planting of larger trout in the fall was definitely ineffectual. Though fall stocking was continued for test purposes until the end of the experimental period, it was agreed that the policy to be recommended for the future was to plant only legal-sized trout and to plant these in the spring and as sustaining plants through the fishing season.

The very considerable importance of wild trout in the Pisgah fishing during the experimental period was recognized. The entire 1937 catch of 6,322 trout was unmarked and might be considered wild trout, though a few might have been part of several plants of 3-inch trout that were stocked before the experiments were begun. In 1938, of the 5,527 trout taken, 5,286 were unmarked and 241 (4 percent) were marked. Of the 7,667 trout taken in 1939, 6,449 were unmarked and 1,218 (16 percent) were marked.

In 1940, when legal-sized trout were first stocked in the spring (though fall stocking was continued), the improved fishing thus produced nearly doubled the fishing effort, so that 14,310 trout were taken. Of these, 7,301 were unmarked and 7,013 (49 percent) were marked. Roughly, six out of seven of these marked fish had been part of the 13,404 planted that spring. For the most part, the remainder belonged to the 1939 fall plant of 19,317 trout, but the 1937 and 1938 fall plants were represented.

In 1941, although fishing pressure had increased so that a total of 18,373 trout were taken, the unmarked trout in this catch increased only to 7,461. Of the 10,912 marked fish that were taken,



A Pisgah rainbow trout stream.

four out of five had been planted in the spring of the same year.

In view of the increase in fishing effort for 1940 and 1941 (over 1938 and 1939 in particular), it is not surprising that there was also some increase in the annual take of wild trout. What may be surprising to many is the very slight extent of this increase in view of the heavier fishing pressure of the latter years. The very slight increase appears to indicate the protection afforded wild or native trout by the stocking of large hatchery trout under properly controlled conditions.

For the 5 experimental years the annual take of unmarked trout averaged 6,564.

After 1941, when hatchery trout were no longer marked before planting, the

number of native trout taken each year was at least equal to the average stated and probably higher. Stream conditions in the Pisgah were at least as favorable on the average after 1941 as before. The many miles of new roads built (in part by the CCC) in the Pisgah just before and during the first years of the experimental period, had become fixed by 1942. The banks had been planted with vegetation, and erosion had practically ceased. The decrease in erosion had permitted the streams to clear themselves of sediment to a considerable degree, and so to harbor larger populations of aquatic insects of food value to the trout. This meant a greater fish-carrying capacity for the stream. After 1941, as stated, native trout probably entered the creels to an equal or greater extent than they had since the beginning of the stream-management studies.

The final evidence of the success of a program is the response it wins. On the Pisgah success has been measured in terms of "fisherman days." These fisherman days represent fishing trips taken by individual anglers and--as an angler pays a dollar a day to fish on the Pisgah and so plans to make a day of it--average about 7 hours each. In 1937, the year the Pisgah studies were begun, there were

1,091 fisherman days. During 1946, there were 8,202 fisherman days. The data are given in tables 1 and 2.

The accusation that the Pisgah system represents "an open-air fish market" is refuted by the evidence that fishermen do have to work for the trout they take in the Pisgah. In some years the effort seems greater than in others. In 1937, the first year of the study, the average catch was 5.8 trout per fisherman. In 1946, the average catch was 4.3. In other words, in 1937 it took 1 hour and 13 minutes, on the average, to catch a trout, and in 1946 it required 1 hour and 38 minutes. An angler who has the acquisition of food primarily in mind, can hardly be expected to devote that much time to casting for trout having an average weight of a quarter of a pound or so. It is true that a surprisingly large percentage of Pisgah anglers either take or kill no fish at all, but this only strengthens the argument that fish is not all that brings fishermen to the Pisgah streams. Those who have been fortunate enough to discover this well-watered southern Appalachian highland country--to fish its forest-shadowed mountain streams, clear and cool, tumbling from heights unknown above the Mason-Dixon line--will understand.

TABLE 1.--Summary of 10 years' fishing for the entire stream-management area of the Pisgah Ranger District of the Pisgah National Forest (Pisgah Game Preserve and the Sherwood Wildlife Management Area)

Year	Fisherman days (No. of anglers)	Total catch of trout	Average catch of trout	Legal-sized planted in spring or as sustaining plants	Legal and near-legal sized planted in fall	Small trout (fingerlings) planted in summer
1937	1,091	6,322	5.8		39,325	
1938	1,112	5,527	5.0		26,118	8,000
1939	1,605	7,667	4.8		19,317	4,000
1940	2,829	14,310	5.1	13,404	24,256	
1941	3,563	18,373	5.1	17,230	37,230	
1942	3,824	18,440	4.8	41,600		
1943	4,471	18,231	4.1	8,712		
1944	4,450	15,520	3.5	15,400		
1945	5,097	23,407	4.6	31,975		
1946	8,202	35,038	4.3	33,846		

No effort has yet been made to increase the number of fish planted beyond those of the early experimental years. The basic difference between stocking efforts now and during those early years is that at first all fish were stocked in the fall. Now, all trout are carried through the winter and stocked in the spring and during the fishing season, resulting in a much more efficient utilization of the stock. From the plants of marked hatchery fish in the formal experimental period, it is known that recoveries as high as 83 percent may be expected. With increased care in stocking, there is no reason why recoveries should not run higher. Then there is the probability already mentioned, that natural reproduction is improving and will furnish more and more in numbers (if not proportionately) of the fish in the fishermen's creels.

Also, where floods are not severe between one fishing season and the next, the greater carrying capacity of the Pisgah streams permits more hatchery trout, not taken one season, to be carried over to the following year. This seems indicated in the records of the trout planted and caught during the 1943 and 1944 fishing seasons. The records indicate that in

1943, though the take of trout numbered 18,231, only 8,712 trout were planted. As the plant in 1942 had been 41,600 and the catch numbered only 18,440, it seemed probable that many of this large plant of trout survived to the following year and, with the native or naturally spawned trout, bore the brunt of the 1943 fishing pressure. The average catch per angler in 1943, however, dropped to 4.1, the lowest value up to that year. This heavy take of trout in proportion to the number planted must have eliminated most of the carry-over fish. The undesirable effects of this appeared in the 1944 catch. That year 15,400 trout were planted in the spring, but the catch (both total and average) dropped still lower: the average catch struck a new low of 3.5 fish per angler, and the total catch of 15,520 trout was the lowest in 4 years. The lesson of the 1943 and 1944 seasons appears to be that though good fishing may be maintained if the number of hatchery trout planted equals the catch, it is undesirable to have too much drain of the adult native and hatchery-planted trout normally carried over from one season to the next. It is undesirable in part because but few adults are left to carry

TABLE 2.--Summary of 10 years' fishing in the Davidson River, the most popular trout stream of the Pisgah Ranger District of the Pisgah National Forest

Year	Fisherman days (No. of anglers)	Total catch of trout	Average catch of trout	Legal-sized planted in spring or as sustaining plants	Legal and near-legal sized planted in fall	Small trout (fingerlings) planted in summer
1937	224	627	2.8		9,500	
1938	519	1,929	3.7		6,535	
1939	350	1,116	3.2		2,000	
1940	728	3,454	4.7	3,809	1,000	
1941	1,175	5,405	4.6	4,162		
1942	1,891	9,212	4.9	11,180		Open continuously through season.
1943	1,550	5,480	3.5	4,112		
1944	1,607	4,821	3.0	5,000		
1945	1,808	8,574	4.7	9,970		Open Thurs., Sat., and Sun., all season.
1946	3,362	13,287	4.0	14,279		Open Thurs., Sat., and Sun., all season.

on natural reproduction, but more particularly is it undesirable because for a period of the year there is a failure in the proper cropping of the aquatic insects that constitute the food of a trout. This adjustment of trout population to the stream's food supply at all times, in and out of the fishing season, as was mentioned, is considered one of the distinguishing characteristics of the Pisgah system of trout-stream management.

This brings up the question of how the Pisgah system differs from other recognized systems of trout-stream management. Though, as practiced, no sharp line often may be drawn between one system and another, it is desirable to understand the characteristics of each. Four such systems may readily be recognized. It is convenient to associate each with an area where it is known to be practiced, even granting that in no case did the system necessarily originate there. The first may be called the Michigan system. The Michigan fishery biologists consider that the natural reproductive capacity of their waters is so great that hatchery propagation is uneconomic (Hazzard and Shetter, 1938).

The second system might be called the Vermont system because of the emphasis given it in the controlled Vermont test-water studies (Lord, 1946), but it was practiced blindly for half a century or more before the start of these studies. This system relies on the improvement of trout fishing through the stocking of fingerling trout.

The third system is used where fishing pressure very considerably exceeds that which the stream is able to meet through natural reproduction. It may be called the New Jersey system. Reliance is placed on the stocking of streams with legal-sized trout to meet heavy fishing pressure, as with the Pisgah system, but the work is reduced to the least common denominator. No attention is paid to food supply, for fishing pressure is likely to be so heavy that the planted hatchery trout are usually caught from the stream before they have time to suffer from lack of food. The practice comes closer to creating temporary fishing opportunities that are promptly enjoyed by the fishing

public, than to meeting existent fishing-pressure demands. The system has been used with success in extremely heavily populated areas, where conditions do not permit the controls possible on such fish and game management areas as the Pisgah.

The Pisgah system is listed fourth in this grouping of trout-stream management systems. It has already been discussed in some detail but may be reviewed briefly. Under this system the supply of wild trout is supplemented with legal-sized hatchery trout, just to meet the fishing pressure. The emphasis is on the full utilization of the natural food supply of the trout at all times. During the fishing season this food supply is considered to function mainly as a maintenance diet to keep the legal-sized trout in condition until caught or until their stock is sufficiently thinned by the end of the fishing season to take up the function of growth. Stocking of the larger trout begins in the spring in time to permit full utilization of the spring pulse or emergence of early aquatic insects. This system is advocated for heavily fished game and fish management areas, where rather close control is both desired and possible--a situation such as exists on the Pisgah--close control that may be self-supporting through the requirement of a special permit to fish.

Where such controls are possible and where heavy fishing pressure must be met with the stocking of legal-sized trout, the Pisgah system is recommended as giving satisfaction to fishermen and to conservation agencies. Ten years of testing have shown that the system works. Mistakes have been made, but they have served as tests of what not to do. Whether or not the system is pleasing to the fishermen, is shown by the increase from less than 1,100 fisherman days to more than 8,000 during the 10 years. Proof of satisfaction to the conservation agencies is indicated by the plans of those agencies managing the Pisgah to extend the system to other management areas, and by the confidence of these agencies that in time the income from the special fishing permits will make the Pisgah management work essentially self-supporting.

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REGENERATION OF DORSAL AND ADIPOSE FINS

Studies in Michigan to determine the effects of removing the adipose and dorsal fins (David S. Shetter: Report No. 1091 of the Michigan Institute for Fisheries Research, "Progress Report on the Control Experiments Involving Marked and Unmarked Lake Trout Fingerlings at the State Fish Hatchery") indicated that 2.8 percent of the lake trout fingerlings with these fins clipped, showed complete regeneration of both fins--so that if the fish had not been kept in a separate pond, they would have been considered unmarked. Although some regeneration of either or both fins occurred in 47.6 percent of the fish, 91 percent of these were considered clearly recognizable as having been marked.

In the summer of 1946, for the purpose of obtaining more data on fin regeneration, approximately 2,000 black-spotted trout with dorsal and adipose fins removed were placed in a pond at the

U. S. Fish-Cultural Station at Creston, Montana, for over-winter holding. When these fish were marked, every effort was made to have the appropriate fins completely removed.

Examination of these trout (which averaged about 8 inches in length just prior to planting in June 1947) showed that approximately 21 percent had a partly regenerated dorsal fin and 4.3 percent had a dorsal fin that could be considered normal. On all the trout that had a regenerated dorsal, it was obvious that the fin had been removed, as only a small part (usually the forward end) had grown to full size. The 4.3 percent had either regrown the dorsal fin completely, or--despite the care in marking the group--they had never had the fin clipped. In contrast to the findings in Michigan, no regeneration of the adipose fin was noted among these fish.

PROPAGATION PROBLEMS AMONG THE TERRAPIN CULTURISTS

Rats, mice, seagulls, mink, and other natural enemies have long been recognized as serious problems for those engaged in the artificial propagation of the diamond-back terrapin, which is particularly vulnerable during its first winter. In view of recent studies, however, terrapin culturists may expect to increase their total production by safeguarding the unhatched diamond-back. Dr. H. F. Prytherch of the Fisheries Laboratory, Beaufort, North Carolina, reports that it has been discovered that the quantity of eggs laid in the sand beds is nearly twice the number which hatch later. This loss is due to the cannibalism of many adult female terrapin, which devour a considerable percentage of the eggs as they are being deposited in the nests

by other terrapin. Overcrowding is apparently a major factor, as the damage is smaller in pens having less concentrated brood stock. Thus 252 females in one pen produced 2,895 young, as compared with the 3,025 young hatched in an adjoining pen that contained 600 females.

During the same studies a period of excessive precipitation killed several young terrapin, necessitating a special drainage arrangement for the egg beds. These circumstances may have had an unusual effect upon the terrapin embryos, as three of the newly hatched terrapin had no legs and were freak specimens such as had not been found previously in a total hatch of more than 226,000 diamond-backs.

Oh Cod, Where Is Thy Cackle!

The codfish lays a million eggs,
The helpful hen but one.
But the codfish doesn't cackle
To tell you what she's done.
And so we scorn the codfish coy
While the helpful hen we prize--
Which indicates to thoughtful minds:
It Pays to Advertisel
(N. F. I. Flashes)

THE CANADIAN FISH CULTURIST

Issued for the first time in November 1946, this bulletin has been prepared by the Department of Fisheries, Ottawa, Canada, to serve as a medium for the exchange of information and opinion regarding fish-cultural activities--modifications and improvements in fishery techniques, management, and equipment--in the Dominion of Canada. The first issue presented several excellent articles which

described recent experimental work: introduction of whitefish and pike-perch in saline water, restoration of trout by poisoning perch and restocking, rearing-pond fertilization with ammonium nitrate, and "caplin" as host for a microsporidian. The bulletin will be issued as material warrants. Copies of future issues may be obtained by writing to the Department of Fisheries, Ottawa, Canada.

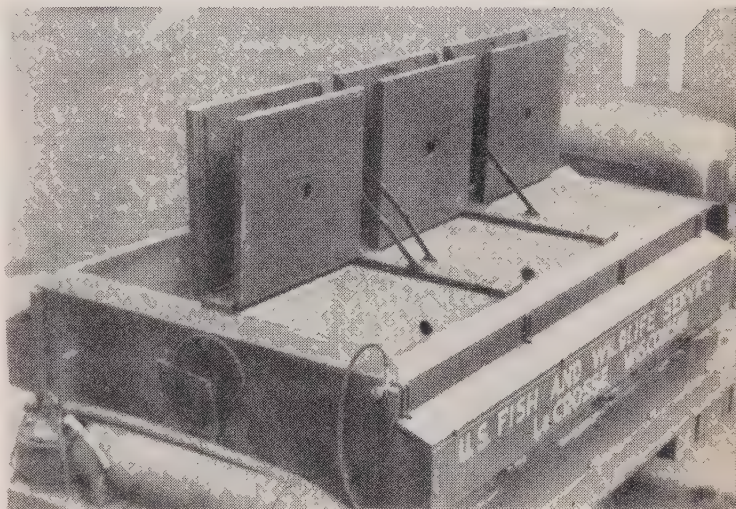
FISH DISTRIBUTION UNITS

CONSTRUCTION OF SIX-COMPARTMENT AND TWO-COMPARTMENT UNITS

T. H. Copeland
Fish and Wildlife Service
Minneapolis, Minnesota.

THE TRANSPORTATION of live fish from hatcheries and salvage operations is almost as old as the sport of fishing. The difficulties of raising fish in the hatcheries constitute perhaps less than half the battle of restoring fishing waters or restocking lakes and streams. Unless those fish are properly and efficiently transported to the waters in need of stocking, millions of fish in the hatcheries will not contribute to better sport for the millions of fishing enthusiasts.

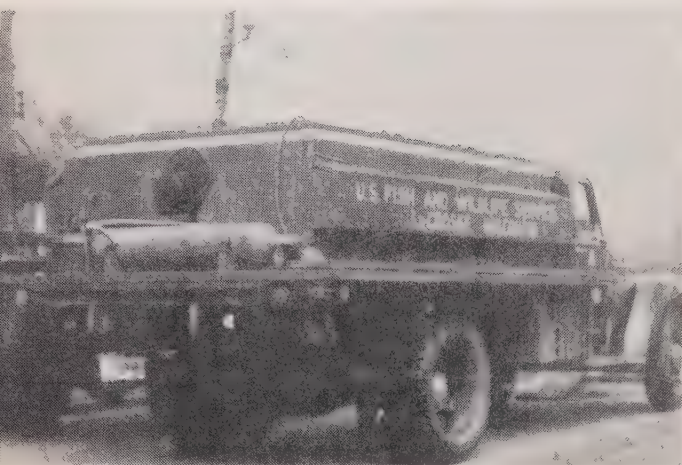
Equipment for the transportation of live fish has ranged from the primitive to the most modern means of transportation. Live fish have been moved by pail and can, by tank (plain and complex), by specially designed truck and railroad car, and by airplane. In many of the isolated areas, the equipment must remain simple. In Colorado and other Rocky Mountain States, trout and other species are often carried in large oblong cans so constructed as to fit comfortably on each side of a sure-footed mule's "ridge-pole." For many years, the Fish and Wildlife Service (and formerly the Bureau of Fisheries) and several State conservation departments have used railroad cars equipped with tanks, cans, air compressors, and other mechanical devices. Likewise, specially equipped boats have been used for transporting large numbers of live fish over fresh- and salt-water areas. Many State organizations are using airplanes, with varying degrees of success, for the transportation of live fish to remote areas.



With the greatly improved highway system, shipments of live fish for distances of 300 miles and less can best be effected by the use of motor trucks. Several new motor-truck distribution units have been devised, improved progressively and constructed from practical experience. The Fish and Wildlife Service has conducted numerous experiments in the study of distribution. The present paper offers the results of several of these experiments and particularly a transportation unit found practical and efficient for live-fish shipments.

AERATION

As a number of fish in a container will soon exhaust the supply of oxygen, it is necessary to replenish the supply. The means of replenishment generally falls



into these categories or methods:

1. Aeration by circulation of water through a Venturi valve.
2. Aeration by spraying.
3. Aeration by forced air, i.e., by the use of air compressors.
4. Aeration by introduction of "canned" oxygen.

Aeration by Means of Circulation of Water

The circulation of water among the fish compartments has been effected by the installation and use of a water pump driven by a 1-horsepower gasoline engine. The pump has a 1½-inch suction and discharge and is capable of supplying approximately 3,000 gallons of water per hour at 10-foot static suction lift. Pressure gauges indicating the hydrostatic pressure of the circulating water system are located in the cab of the truck.

Considerable experimental work has proved conclusively that the mixing of natural atmospheric oxygen with water is superior to other methods of aeration. The results of these experiments have indicated the desirability of the introduction and use of a special mechanism known as a Venturi valve, which is shown in the Side View sections of the drawings. The Venturi valve must be placed between the water pump and the intake of the tank; if the valve is placed elsewhere, the

results are not satisfactory. Attached to the valve is a 5/16-inch copper tubing. The tubing extends to the uppermost part of the tank or above the normal water level therein. As the water passes through the valve, a suction of air through the tubing changes the water to a white or milky color. When it has become saturated with oxygen, the water is directed into the fish compartments. The Venturi valve merits more than casual consideration; the adoption of this device, when used as described here, is recommended for the fish-distribution unit.

The alternative, aeration by spraying of water into the fish compartments, permits the water on its downward fall to gather oxygen and release carbon dioxide at the same time. The spraying system is highly efficient in that it will effect the removal of carbon dioxide. As the spraying system is not included in the six-compartment unit, however, further elaboration of its qualities will not be offered.

Aeration by Forced Air via Air Compressor

To introduce compressed air into the fish-carrying compartments, a small air compressor run by a 1-horsepower gasoline motor with a V-belt drive is used. The air from the compressor is forced into



a 6- by 30-inch equalizing tank and released to the fish-compartment tanks. The air from the equalizing tank is piped directly through a 1/2-inch pipeline to a brass box in the floor of each compartment. Embedded in this box is a special Aloxite filter plate or carborundum stone of low porosity. The air passing from the stone is broken into fine particles or bubbles and released into the water. Details of the construction of the aerating system are shown in the Detail of Air Inlet sections of the drawings. Gauges indicating the pounds of air pressure released into the water in the compartments, are set in the cab of the truck.



ICE COMPARTMENTS

Aeration via Tank or "Canned" Oxygen

A third means may be used for proper aeration of the water in a unit. "Canned" oxygen may be forwarded to the compartments through the compressor line and released directly through the carborundum stone. The availability of this third source of aeration provides a "triple threat" built into one transportation unit. When the method of aeration by compressor is being used, it is impossible to introduce oxygen from the tank. On the other hand, it is possible--although unnecessary--to aerate water by compressed air and by circulation at the same time.



Naturally, the temperature of the water in which the fish are carried also has an effect upon the number of fish that may be carried in any given vessel. As water holds more oxygen at a low temperature than at a high temperature, it is essential to keep the temperature as low as is consistent with the well-being of the fish. In caring for fish in transit, an efficient attendant will watch for signs of distress. In order that the attendant may transport a maximum number of fish, he should have at all times a supply of ice which may be used to control the temperature of the water. Radical changes in temperature affect the fish adversely. Experience has shown that an increase or decrease over a wide range may kill the fish even though the effects may not be noted before the fish are stocked; therefore, ice should be used to bring the temperature gradually near that in which the fish will be planted. Specially designed ice compartments have been constructed and placed on the exterior of the tanks. Each of the two compartments is 9 feet 11 inches long by 6-1/2 inches wide by 13 inches deep; each is so constructed as to take up a minimum amount of space and at the same time cover with ice the intake and exit water pipes to the fish compartments. Approximately 200 pounds of crushed ice can be carried in each of the ice compartments.

WATER FILTER

For years there has been a demand for an instrument to purify the water while live fish are being transported. This demand has now been met with a filter which has demonstrated a limited efficiency. More research will be necessary for the development of a completely practical water filter for use in transporting live fish.

The filter installed is simple in design and construction. It may be made from the following materials:

- 31" of 4" iron pipe
- 1 - 2-1/2" bushing
- 1 - 1-1/2" x 2" nipple
- 4 - 3/8" wing nuts
- 4 - 3/8" x 3" steel cap screws
- 1 - 2-1/2" wire core 30" long
- 1 - 5" x 5" x 3/4" flat iron for filter end
- 1 - filter cloth to cover core.

Detailed information about the construction of the filter may be noted on the drawing for the six-compartment unit.

CARRYING CAPACITY OF THE SIX-COMPARTMENT UNIT

The carrying capacity of the unit is dependent upon a number of factors which

may or may not be controlled. For instance, the temperature of the water may be lowered by the use of ice when conditions warrant such action. However, the temperature of the water may drop suddenly because of prevailing weather conditions, and such a drop may be harmful to fish life. Such incidents are rare and have not heretofore been considered of sufficient importance to justify efforts to work out a remedial adjustment. Under normal conditions, the fish-carrying capacity of the unit is as follows:

Weight (trout)

- 80 pounds of 7-inch yearlings per compartment.
- 480 pounds of 7-inch yearlings per unit.
- 50 pounds of 3-inch fingerlings per compartment.
- 300 pounds of 3-inch fingerlings per unit.

Numbers (trout)

- 6,000 - 2- to 3-inch fingerlings per compartment.
- 36,000 - 2- to 3-inch fingerlings per unit.

(bluegill sunfish)

- 50,000 - No. 1 fingerlings per compartment.
- 300,000 - No. 1 fingerlings per unit.

(largemouth black bass)

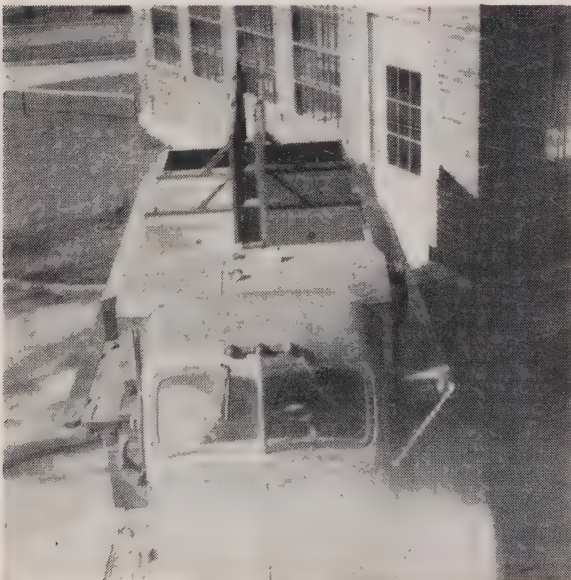
- 8,150 - No. 3 fingerlings per compartment.
- 48,900 - No. 3 fingerlings per unit.

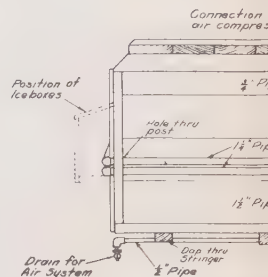
CONSTRUCTION OF SIX-COMPARTMENT UNIT

Dimensions and bill of materials used in the construction of the six-compartment distribution unit are as follows:

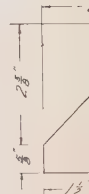
Dimensions

Length (over-all)	9 feet 3 inches
Length (less machinery platform)	6 feet 8 inches
Width	3 feet 3 inches
Height	2 feet 2 1/2 inches
Weight (loaded)	7,830 pounds
Weight (empty)	2,430 pounds
Water depth	20 inches
Cat-walk around body	13 feet 3 inches by 7 feet 9 inches

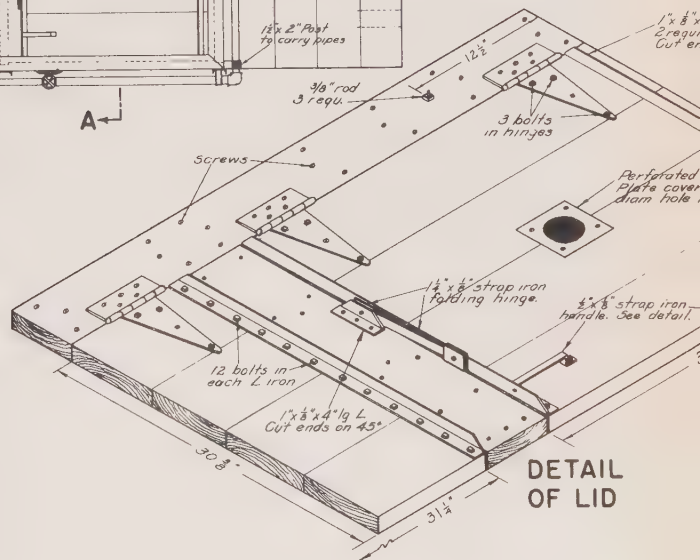




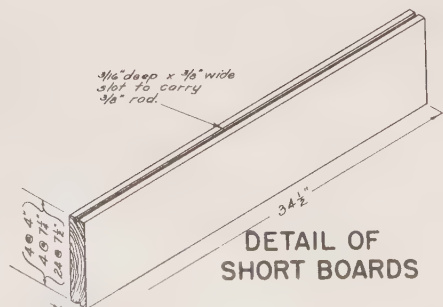
SIDE VIEW



TOP VIEW

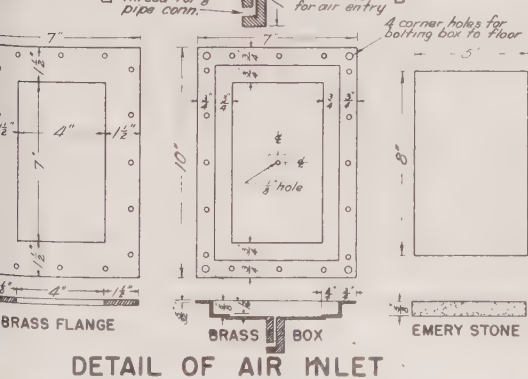
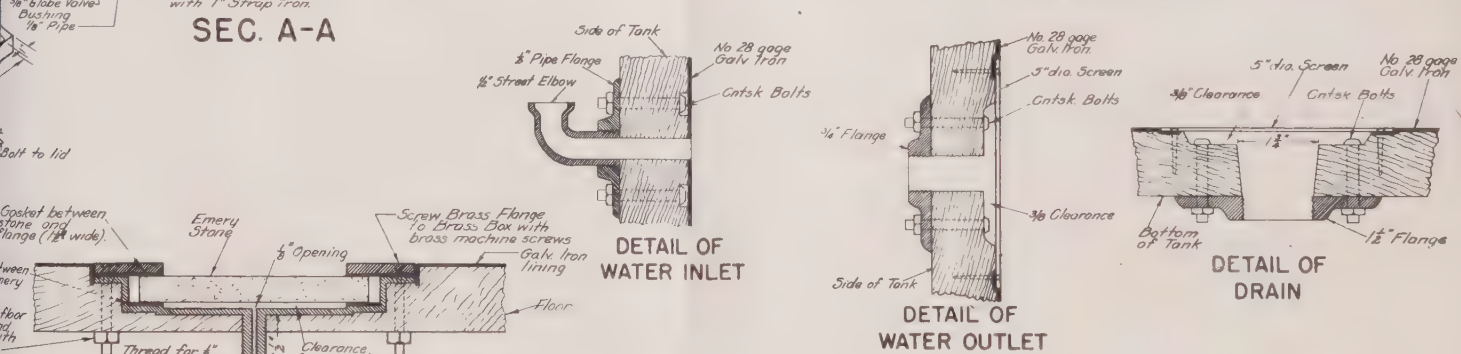
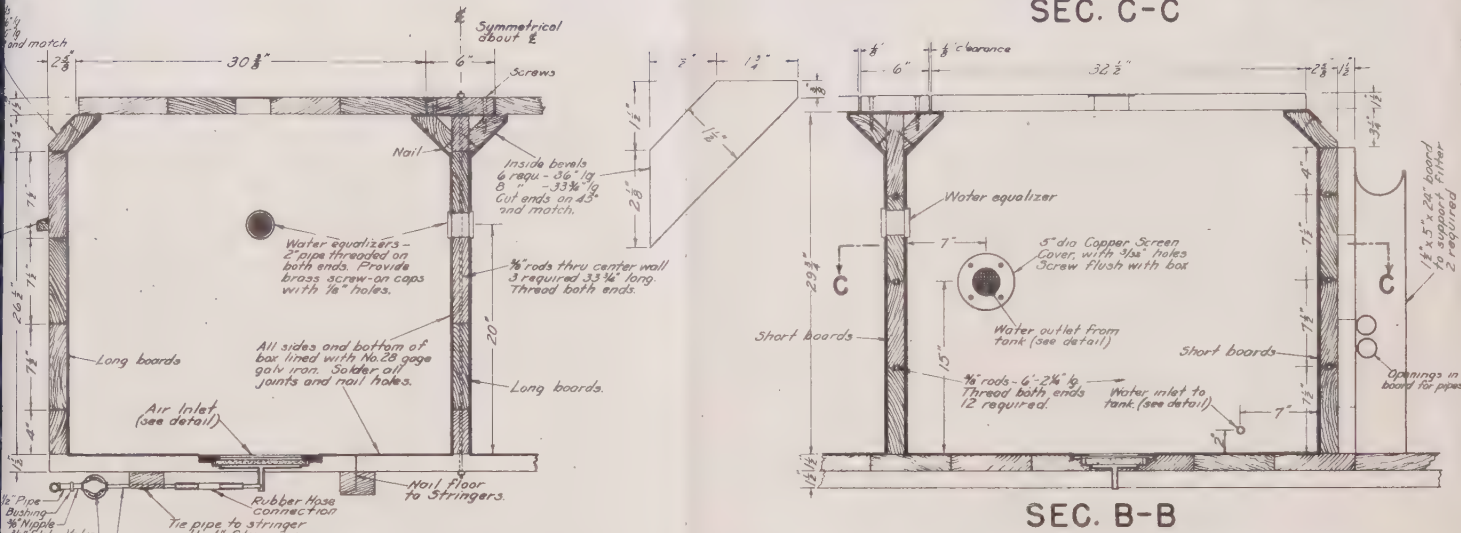
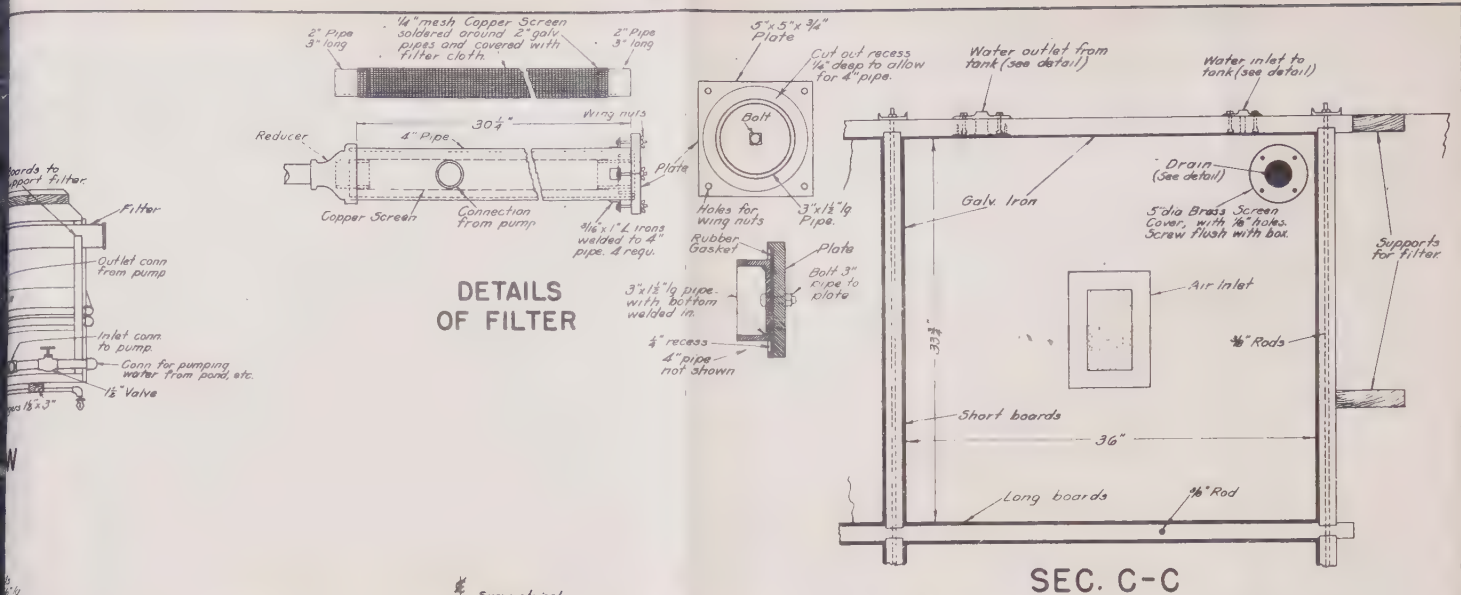


DETAIL
OF LID



DETAIL OF LONG BOARDS

DETAIL OF SHORT BOARDS



U. S. DEPARTMENT OF THE INTERIOR FISH AND WILDLIFE SERVICE	
PLANS FOR 6-COMPARTMENT FISH DISTRIBUTION TANK	
DESIGN <u>GFD</u>	
PLOTTED <u>JRW</u>	
TRACED <u>JRW</u>	
CHECKED <u>JRW</u>	
APPROVED <u>JRW</u>	
SCALE AS SHOWN	DRAWING: F-2006

$1'' \times 8''$

ELEVATION

DETAIL OF ICEBOX

VERT. SEC.

DETAIL OF SHORT BOARDS

12 required

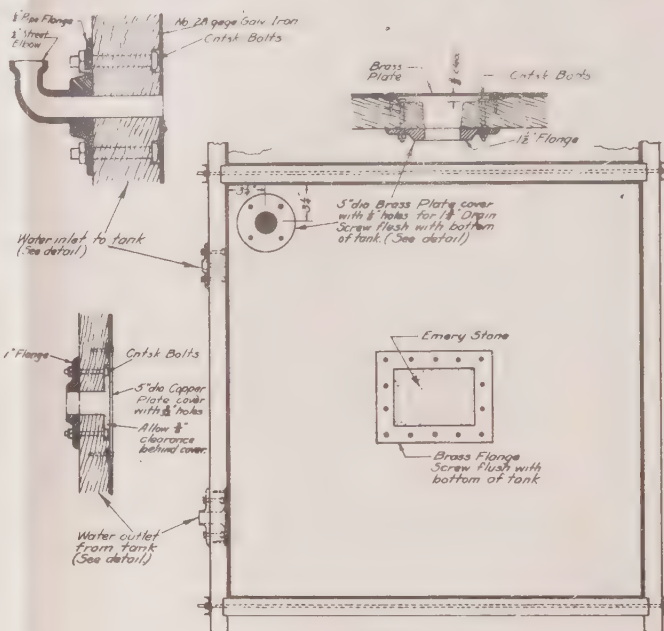
DETAIL OF LONG BOARDS

8 required

DETAIL OF AIR INLET

Technical drawing of a rectangular box, likely a safe or a secure container, showing dimensions and components. The drawing includes the following labels and dimensions:

- Dimensions:**
 - Top edge: 6'-8"
 - Right edge: 4'-0"
 - Bottom edge: 1'-8" x 4'-10"
 - Left edge: 1'-8" x 4'-10"
- Components and Labels:**
 - Perforated Brass Plate Cover over 3" dia hole in lid:** A circular cover with a grid pattern, labeled "4 required".
 - Folding Handle (countersunk in lid):** A handle mechanism on the lid.
 - 1 1/2" x 3 1/2" Lg. Ls 4 required:** A label pointing to the handle mechanism.
 - 1 1/2" x 4" Lg. L:** A label pointing to the handle mechanism.
 - Strap Iron Folding Hinge:** A hinge mechanism on the side of the box.
 - Bolts:** A label pointing to the bolts securing the lid.
 - A:** A label pointing to the handle mechanism.
 - B:** A label pointing to the handle mechanism.



SEC. C-C

DRAWING: F-2008

Bill of Materials

<u>Lumber</u>	
<u>Redwood</u>	
16 pieces	1-3/4" x 7-1/2" x 6'
10	1-3/4" x 7-1/2" x 10'
4	1-3/4" x 5-1/2" x 10'
2	1-3/4" x 5-1/2" x 6'
36	1-3/4" x 7-1/2" x 3'
38	1-3/4" x 5-1/2" x 3'
2	1-3/4" x 5-1/2" x 12'

<u>Fir</u>	
2	1-1/2" x 3" x 14'
2	2-1/2" x 3" x 14'
2	1-1/2" x 5-1/2" x 14'
2	1-1/2" x 9-1/2" x 14'

<u>Galvanized steel</u>	
12 sheets	- 28 gauge, 3' x 8'

<u>Channel iron</u>	
23'	- 1/2" x 1-1/2"

<u>Angle steel</u>	
36'	- 1/3" x 1"
2'	- 1/4" x 2-1/2"
6'	- 1/8" x 1"
4'	- 3/16" x 1"

<u>Flat steel</u>	
20'	- 1/8" x 1"
10'	- 1/8" x 1-1/4"
6'	- 3/16" x 1"
2'	- 1/4" x 2"
1 piece	- 5" x 5" x 3/4"

<u>Steel machine bolts</u>	
4	- 3/8" x 3"
4	- 5/16" x 2"
4	- 1/4" x 3/4"

<u>Lock bolts</u>	
6	- 6"

<u>Carriage bolts</u>	
24	- 5/16" x 2"
4	- 5/16" x 2-3/4"
2	- 1/4" x 2"
4	- 3/8" x 2-1/2"
6	- 3/8" x 5"
4	- 3/8" x 8"

<u>Flat-head screws</u>	
10	- #8, 1-3/4"
10	- #10, 1-1/2"
60	- #10, 2-1/2"
24	- #12, 1-1/2"
24	- #12, 3"
360	- #12, 3-1/2"

<u>Round-head screws</u>	
18	- #9, 1-3/4"
18	- #9, 7/8"

<u>Brass screws</u>	
24	- #10, 1-1/4"

<u>Hexagon nuts</u>	
24	- 3/8"

<u>Wing nuts</u>	
8	- 3/8"

<u>Nipples</u>	
6	- 1-1/2" x 2"
1	- 1-1/2" x 11"
1	- 1-1/2" x 12"
1	- 1-1/4" x 5"
2	- 1-1/4" x 2"
1	- 1-1/2" x 2"
6	- 1-1/2" x 3"
6	- 1/2"
6	- 1/2" x 2-1/2"
6	- 1/2" x 1-1/2"
7	- 2" x 3"

<u>Copper tubing</u>	
18'	- 5/16"
10'	- 3/8"
40'	- 1/8"

<u>Rods</u>	
22'	- 3/8"

<u>Water hose</u>	
1'	- 2"
1'	- 1-1/4"

<u>Suction hose</u>	
16'	- 1-1/2"

<u>Brass plates</u>	
6	- 3/4" x 4-1/8"

<u>T-hinges</u>	
6 pair	- 8"

<u>Strap hinges</u>	
6 pair	- 6"

<u>Carborundum stones</u>	
6	- 5" x 8"

<u>Gas engines</u>	
2	- 1 horsepower

<u>Air gauges</u>	
3	- low pressure

<u>3-way ells</u>	
2	- 3/8" x 3"

Tees			
1	- 1-1/4"	x 1-1/4"	x 1-1/2"
1	- 1-1/2"	x 1-1/2"	x 1-1/4"
1	- 1"	x 1"	x 1-1/2"
2	- 1"	x 1"	x 3/4"
2	- 3/4"		
2	- 1-1/4"	x 1"	x 3/4"
2	- 1"	x 3/4"	x 3/4"
8	- 3/8"		

Ells	
2	- 3/4"
4	- 1-1/4"
4	- 1"
6	- 1-1/2"
2	- 3/4"

Floor flanges	
6	- 1-1/2"
6	- 1/2"
6	- 3/4"

Joint unions	
1	- 1-1/2"
1	- 1-1/4"

Cap screws	
4	- 3/8" x 3"

Bushings		
1	- 2"	x 1-1/2"
2	- 1"	x 3/4"
8	- 3/8"	x 1/4"
8	- 1/4"	x 1/8"

Tube fittings	
6	- 1/4" x 5/16"
6	- 1/4" x 3/8"
6	- 1/8" x 1/8"

Pipe	
31"	- 4"

Piping	
6'	- 1/8"
3'	- 1-1/2"
12'	- 1-1/4"
16'	- 1"
18'	- 3/4"

Couplings	
4	- 2"
1	- 4" x 2"

Lock nuts	
7	- 2"

Gate valves	
7	- 1-1/2"
1	- 1-1/4"

Drain cocks	
4	- 1/8"

Hose clamps	
4	- 2"
1	- 1-1/4"

Street ells	
12	- 1/2"
6	- 3/4"

Suction tees	
6	- 1/2"

Nails	
17	pounds, assorted

Copper screen	
130	square inches

Piano wire	
5	feet

Lift handles	- 6
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Brass boxes for carborundum stones	- 6
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Air compressor	- 1
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Air regulator	- 1
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Safety valve	- 1
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Water pump	- 1
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TWO-COMPARTMENT UNIT

In addition to the six-compartment unit, the Fish and Wildlife Service makes use of a two-compartment fish-distribution unit. Constructed along the same principles, the smaller unit is more adaptable to the needs in transporting fish from propagation pond to holding shed or hatchery for sorting and distribution. Also, the smaller unit is used advantageously on distribution trips that involve a smaller number of fish.

The two-compartment unit is classified as a portable structure (see accompanying drawing). It is mounted on skids so that it can be placed on and removed from a truck with a minimum of effort. A 3/4-ton truck with overload springs and a four-speed transmission is preferable for use with the two-compartment unit.

Upon request, a bill of materials for this unit will be furnished.

FIGURE 1.--View of fence from downstream. Only short bars were available to complete second section from the right.



NEW TYPE OF FISH FENCE FOR USE IN STREAMS

William C. Herrington¹ and Louis D. Stringer²
Fish and Wildlife Service
Cambridge, Massachusetts.

In the salmon-restoration program being conducted in New England by the Fish and Wildlife Service, possibly the most important problems at the present stage of the work are the population evaluations necessary for accurate information on mortality of young fish in the stream, the escapement of smolts to the sea, and the number of mature salmon which return to the river. Until these population data can be obtained, so that the various causes of mortality can be identified and quantitatively evaluated, it will not be possible to determine what conditions in

the stream are limiting the restoration of salmon runs, nor what conditions regarding escapement of mature fish upstream to spawn are necessary to build up and maintain maximum runs of fish.

To evaluate the upstream and downstream runs of mature fish and smolts and to measure the mortality of young fish in the stream, fish-tight barriers or fences must be installed at selected points. Migratory fish can be counted through these fences, and young fish can be held in a given stream section for successive counts during the season.

Preliminary work of this kind was begun on the Pemaquid River, where screens constructed of hardware cloth were used. Results of this work, examination of reports on similar work elsewhere, and discussions with other workers in this field, led to the conclusion that present types of screens had many limitations when used for this purpose.

A new type of fence or screen has been designed to overcome some of these limitations. A scale model (1 inch to 1 foot)

¹/Mr. Herrington left the Service on February 21, 1947.

²/The authors wish to express their appreciation for the advice and suggestions received from Mr. Frank L. Lincoln in regard to design and construction of the experimental fence. Several members of the North Atlantic staff, particularly Mr. Clyde C. Taylor and Mr. Howard A. Schuck, assisted in some of the work of installation and maintenance.

was constructed in the fall of 1945, and a full-scale experimental model was constructed in the spring of 1946. This latter model (6 feet maximum height and 35 feet in length) was installed in the Pemaquid River in August 1946 and left in place with little attention until November 1946. The fence was allowed to plug up with leaves until there was a difference of 23 inches in water level above and below the fence and the water overflowed the bank around one end.

Experimental Fence

The experimental fence is made of flexible sections which are linked to one another through supporting posts. These sections are interchangeable so that the fence can be lengthened or shortened to suit conditions. The general outline of the fence is shown in figures 1 and 2. The posts, stringers, and rack bars fit together rather loosely and may be taken

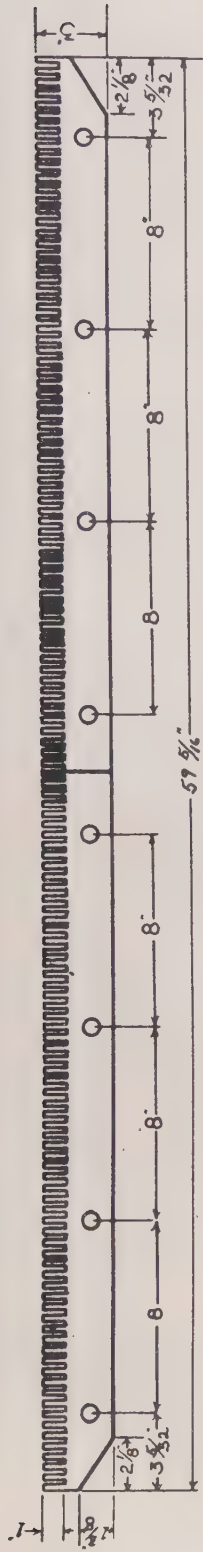
apart easily.

The supporting posts are made of standard 1-1/2-inch galvanized water pipe, through which 1/2-inch holes have been drilled every 2-3/4 inches. The lengths of the posts are 3, 4, and 5 feet, but these can be changed to fit local stream conditions. The stringers or beams are supported at various heights on these posts by placing 7/16-inch brass pins through the holes in the posts just above and below the stringers. Large washers placed between the pins and stringers provide a bearing surface. The brass pins have 1/8-inch holes 2-1/2 inches apart, through which wire or cotter pins are inserted to hold the pins in place.

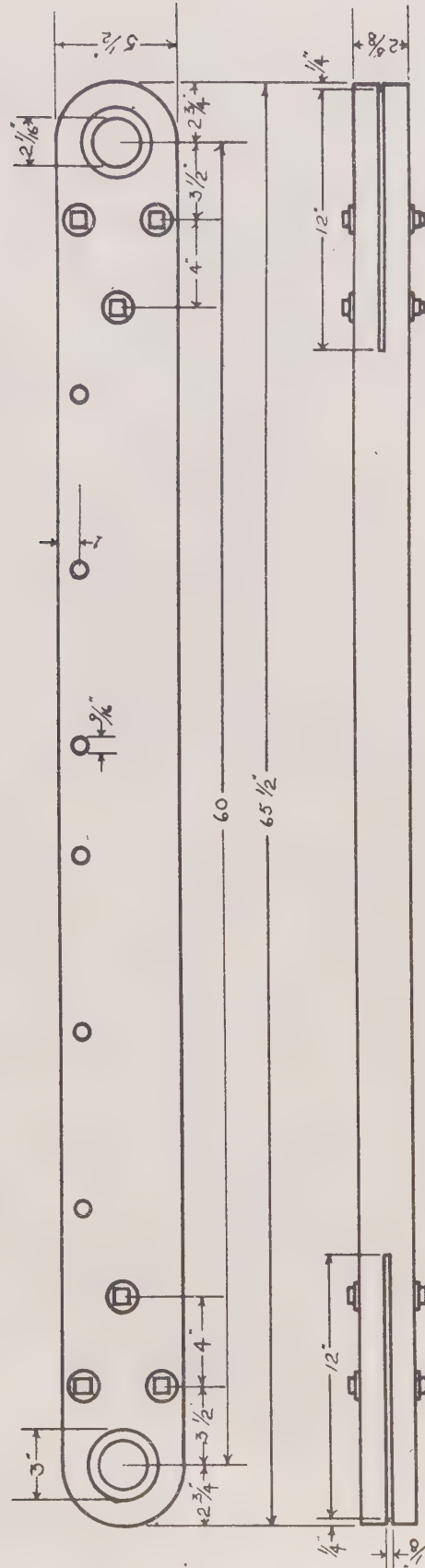
The stringers are made of redwood and have 2-1/16-inch holes bored at either end, spaced 5 feet between centers. These post holes are reinforced by inserting a steel plate, bored with a similar hole, in slots cut horizontally across each end of the stringer and bolted in place as shown in figure 3. The hole in the

FIGURE 2.--View of the fence from overhead, showing the upstream point and supporting bridle.





RACK PLATE



STRINGER

FIGURE 3.--Diagram of stringer and rack plate. Corners in rack plate are cut to clear the taper on the post hole in the stringer.

stringer is flared. This allows the posts to be tilted from the vertical, while the stringer remains parallel with the water surface. These details are shown in figure 4.

The rack plates (figure 3) are made of brass 3/16 inch thick. Galvanized iron could be used instead. Slots 3/16 inch wide have been milled every 1/4 inch in these plates, and the teeth have been bent to a 45° angle. This angle makes it easier to clean the rack with a rake or other toothed instrument. The closed plates have been made by brazing or welding a piece across the openings. The rack plate is bolted to one edge of the stringer as shown in figure 4.

The rack bars are 1/8- by 1-inch hot-rolled, galvanized strip steel. These bars are 3, 4, 5, and 6 feet in length. These lengths can be varied to suit local conditions. One end should be tapered on all edges to facilitate introduction into the slots.

Corresponding parts have been made as nearly alike in dimensions as possible, so that they can be interchanged readily and little time will be required to locate the proper pieces.

Installation

The general assembly of the fence is shown in the photographs.

The position of the stringers depended on the contour of the stream bottom. The bottom stringers using closed-type rack plates were placed close to the stream bed, usually about 6 inches from the lower ends of the posts. With the closed plates on the bottom, any tendency for the fence to shift downstream forced the upper ends of the rack bars more firmly into the slots in the rack plates of the upper stringers. The stringers should be kept as nearly horizontal as possible to prevent any vertical lifting component when a strain is placed on the fence.

Because of the flexibility of the rack bars when supported only near their ends, a third stringer was placed between the upper and lower stringers when bars 4 feet or longer were used.

Wire rope attached to trees along the river bank was used to hold the fence in position. (Where trees are lacking, "dead men" or buried logs can be used.) Small

loops of wire rope were cast on the top and bottom of the end posts and through turnbuckles to anchors on the bank. These ropes were arranged to pull down and to the side. The center post was guyed top and bottom to a bridle (figures 2 and 5) consisting of turnbuckles and wire--and from here, by wire, to either bank. By adjustment of the turnbuckles, the fence was allowed to slope downstream from the vertical. This facilitated cleaning and provided a vertical component for any force exerted against the fence. The openings between the shore and the end posts were filled with sandbags until fish-tight.

The joints of the fence at the posts where the opening was greater than 1/4 inch, were covered with strips of canvas or hardware cloth fastened to the rack bars, the low end buried in the stream bed to the same depth as the adjacent bars.

Blowing under the fence was prevented by driving the bars (which slid easily in the slots) into the bottom. In stony bottom this can be facilitated by digging a shallow trench at the base of the fence, then throwing the gravel back against the base of the bars after they have been driven. Sandbags and boulders were placed along the downstream base of the structure to compact the gravel and to prevent erosion behind the fence by water flowing through the bars over the clogged lower sections. A more effective arrangement would be a continuous row of sandbags along the base with boulders placed on top of them. The stream bottom where the fence was installed ranged from sand to very coarse gravel. The backward slope of the fence (figure 5), varying from the vertical by 14° to 28°, also helped prevent blowing under by providing a downward component from the water pressure, so that the fence was pressed down as well as back.

Two methods of installing the fence are diagrammed in figure 6. Method I shows the fence in the shape of a V pointing upstream. This method was used in the test model and was very satisfactory. Method II illustrates the diagonal type of installation. This method has the advantage of using only two traps, one for downstream migrants, the other for upstream migrants.

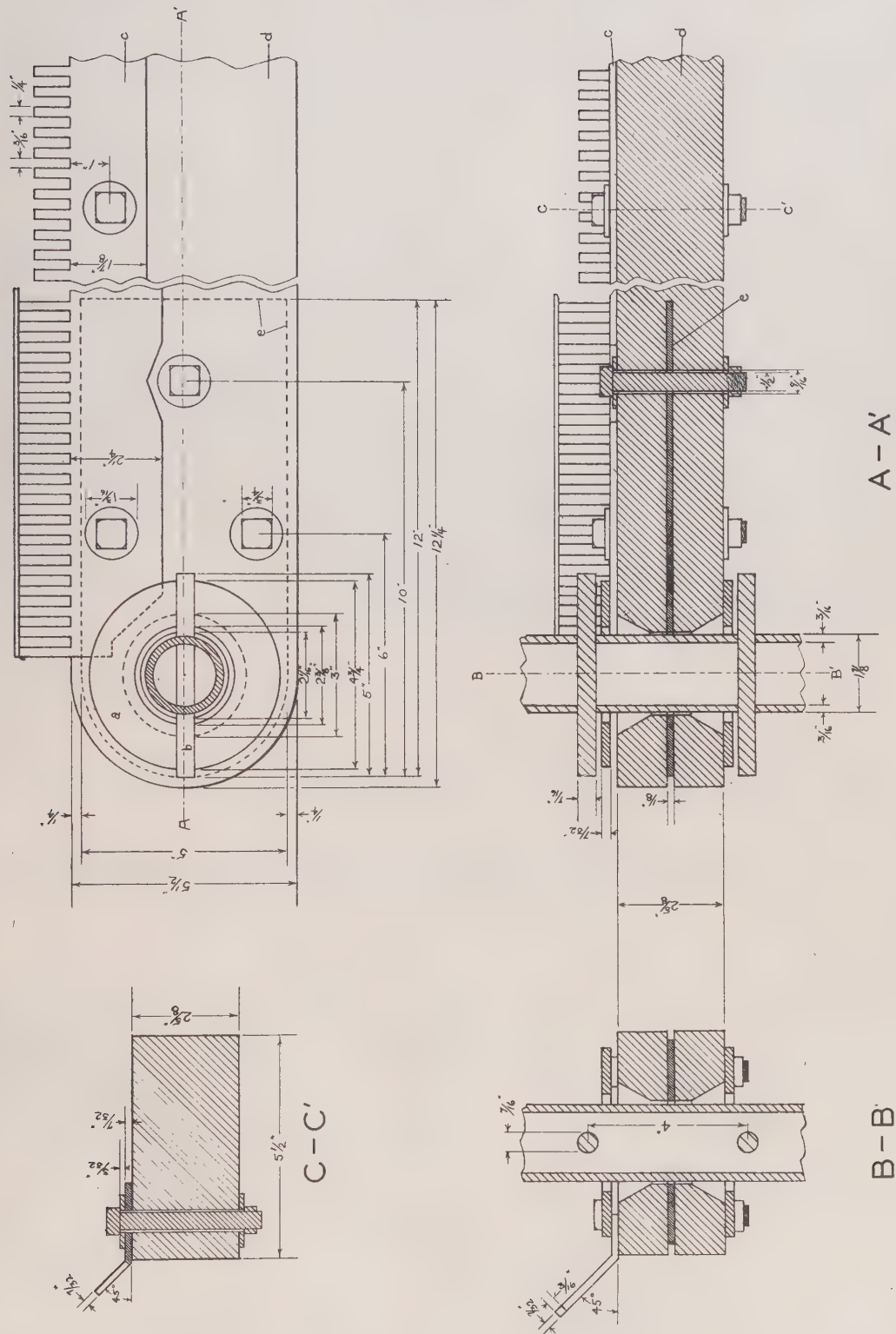


FIGURE 4.--Diagram of one end of assembled stringer. A-A', longitudinal section through mid-line of stringer; B-B', cross section through weir post; C-C', cross section through rack plate bolt; a, bearing washer; b, bearing pin; c, rack plate; d, stringer; e, reinforcing plate.

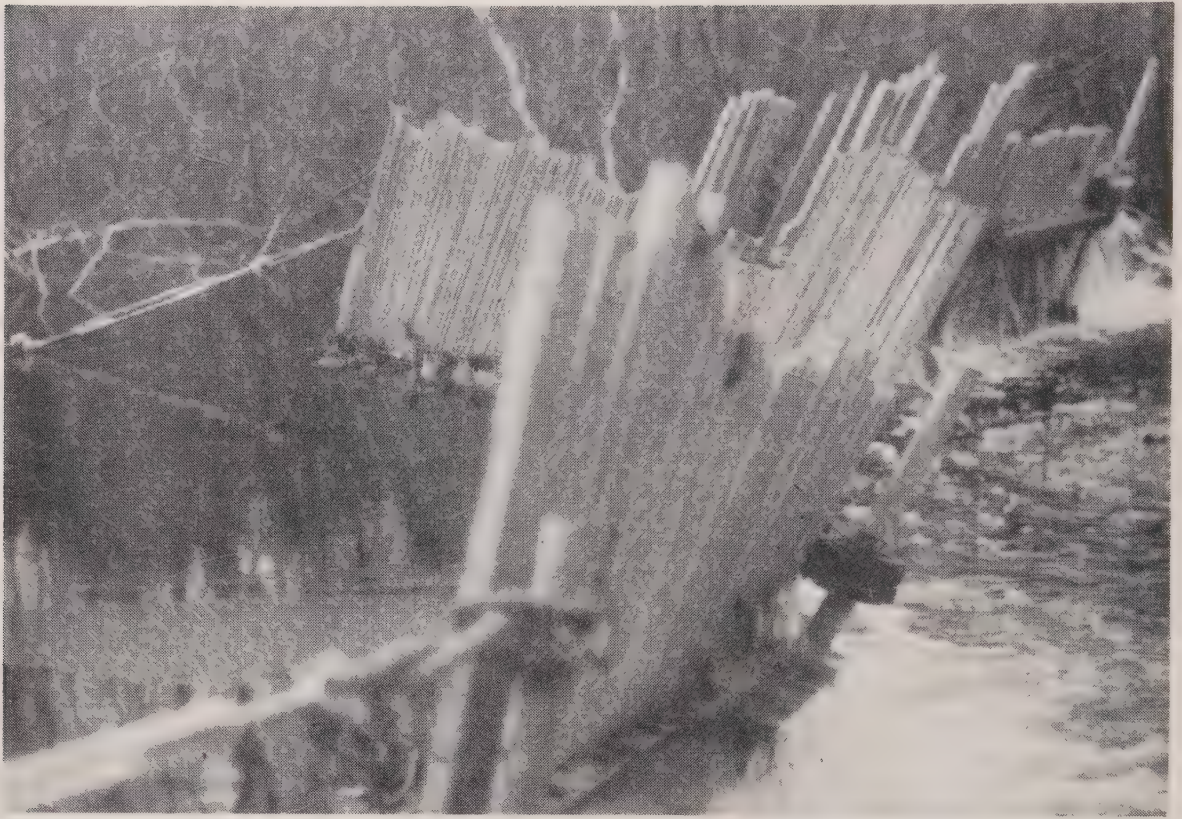
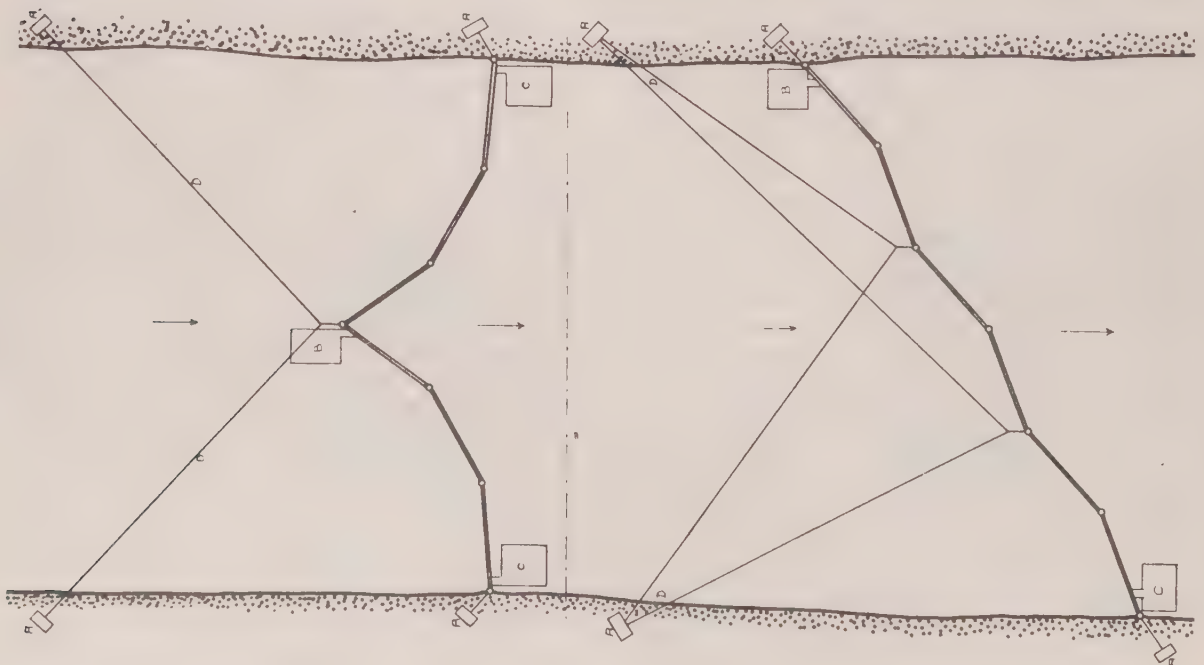


FIGURE 5.--View of fence from right bank, showing backward slope, difference in water level (23 inches), and parts of center and wing bridles with turnbuckles.

FIGURE 6.--Schematic diagram of two methods of installing the fence. A--anchors (trees or "dead men") for guy wires. B--upstream traps. C--downstream traps. D--guy wires. Arrows show direction of the stream flow.



Advantages

Some of the advantages of this type of fence are as follows:

1. It is easy to install, as it is assembled on the site with interchangeable parts and is flexible as to height and length. The experimental fence was installed by four men in 2 days and removed by four men in 3/4 day. It is estimated that, with additional experience and improvement of the fit of slots and bars (which were too tight in this model), three men can install such a fence in 1 day and remove it in 1/2 day.

2. It is sufficiently rugged to withstand any pressure short of an ice or log jam. Practically any strength can be obtained by using sufficiently heavy guy wires and stringers. A log-boom deflector upstream will protect against logs and debris.

3. It can be installed at almost any location along the stream with guy wires of whatever length is needed. Trees, buried logs, and similar material can

be used for anchors. As the fence is temporary, only the owner's permission--rather than ownership of the land--is required for installation.

4. It is easy to clean because of the parallel-bar construction and backward slope.

5. Adjustability of bars in the slots makes it possible for the fence to conform to any type of bottom: ledge, boulders, gravel, sand, or mud. The softer the bottom, the deeper the bars can be driven.

6. Ease of installation and removal makes it possible to install the fence early in the spring and leave it in until ice begins to form.

7. Should the fence under exceptional conditions plug up to the extent that the water flows over the top, the fence is sufficiently rugged to stand up under this pressure, so that the fence itself would not be lost. In addition, if the drop in water level on the downstream side is several feet, it should prevent all (or almost all) upstream movement of fish while this condition exists.

SORTING TABLE

Hubert C. Topel
Fish and Wildlife Service
Tishomingo, Oklahoma.

At many stations the sorting of pond-fish is a major task; it is necessary at almost every pondfish station on certain occasions. Every fish-culturist has his idea on how the sorting should be accomplished, and this is shown by the fact that no single type of sorting

device is used at all stations. At some stations fish are sorted from a dip net held at the water surface, from boxes fastened inside holding tanks, or with tubs and miscellaneous containers; other stations use tables of a more or less elaborate design.

The Tishomingo station has a definite scrap fish problem. Although our inlets are screened, a great number of green sunfish and minnows enter the rearing ponds while in the fry stage. The addition of these fry is a benefit in the rearing ponds for bass at the Tishomingo station, but the same condition creates a problem in the bluegill ponds. Sorting

See also:

Wolf, L. E.

1937. A large fish sorter. Prog. Fish-Cult. 32: 16-17.

1938. Again, fish sorters. Prog. Fish-Cult. 39: 28-31.

is imperative, as almost all of our bluegill fingerlings go into farm ponds.

In sorting green sunfish and other undesired species from bluegill fingerlings, good visibility must be maintained, and for this reason the small fish must be spread thinly on a light-colored surface. We find that the sorting table is much more efficient than other methods tried and causes less damage to the small fingerlings.

The diagram shows construction of the sorting table now in use at the Tishomingo station. In designing this, we patterned after an ordinary four-legged, flat-topped table, to which we added sideboards containing openings cut flush with the table top. The table top was covered with sheet metal, which was held in place by quarter round. The sheet-metal top was given three coats of white paint, and each of the first two coats was sanded to impart smoothness to the finish. Overall dimensions were as follows: height, 3 feet 11 inches (including sideboards, which extended 4 inches above table top); width, 3 feet; and length, 5 feet.

Although six side openings were provided, we rarely use more than four at one time. When possible, we place our table so that the predominant species

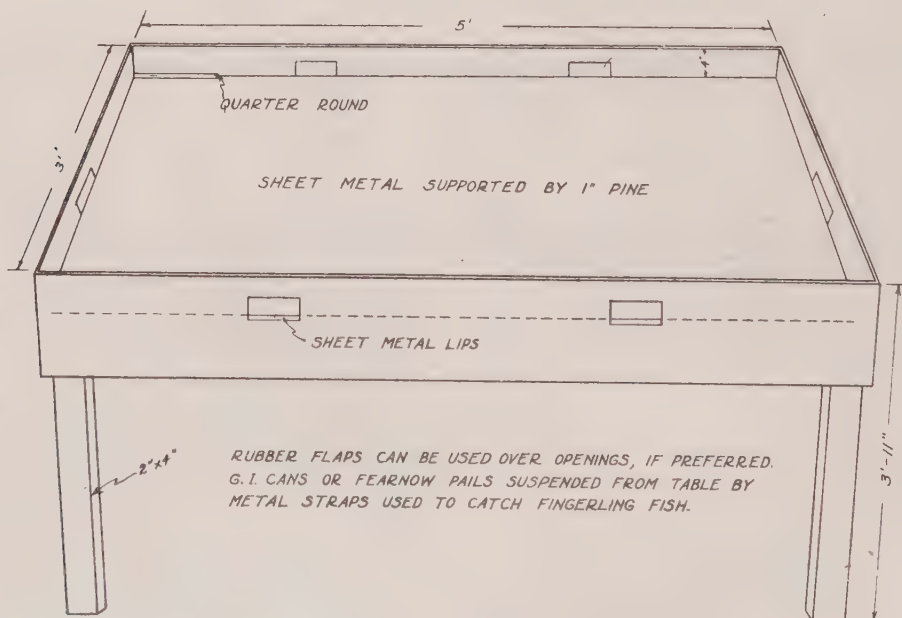
drop from two openings into a holding tank; the less important species go into G.I. cans under the other openings. If G.I. cans were not available, we could easily construct metal straps in order to hang Fearnow pails under the openings. Flaps of light rubber are used to control the ejection of fish when they have passed through the openings.

Bluegill fingerlings that have been sorted over this table have been held for periods exceeding 2 weeks and have shown no ill effects. This is probably due to the film of water that is always present on the table and to the fact that the fingerling fish are not handled; they are pushed through the openings.

We do not claim that our sorting table is more efficient than devices used at other stations, but the construction is simple, the visibility during the sorting operation is good, damage to fingerlings is held to a minimum, and a great number of fish can be sorted in a short time. The table is easily handled: we move it to the Wichita Refuge for operations at that point each season. It creates no storage problem.

We consider the sorting table a necessary part of our fish-cultural equipment.

SORTING TABLE



CONTROL OF

ALGAL GROWTHS

IN HATCHING PONDS

AND RACEWAYS



(Photos courtesy of the authors)

Elmer F. Herman and Wendel Anderson
Wisconsin Department of Conservation
Madison, Wisconsin.

With emphasis being placed on planting more legal trout and fewer fingerlings in Wisconsin waters, the need for more raceways and circular ponds made of cement has increased. The problem of keeping these clear of algal growths has entailed a great deal of time and expense. Where the growths are not removed, some of the fish food sinks into these growths, thereby causing a loss and, secondarily, bringing about contamination of the raceway by decay.

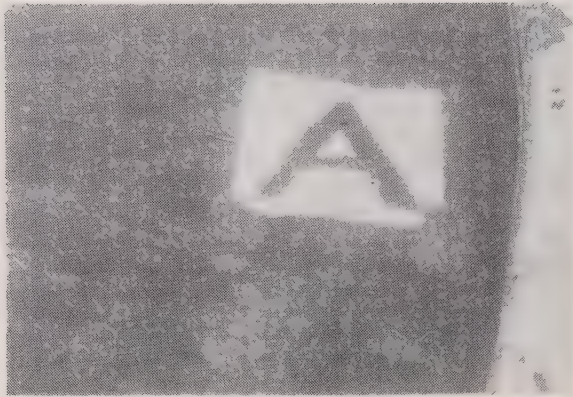
Controlled copper-sulphate drips employing the siphon principle have been used with some success. With these, the desired concentration in parts per million of copper sulphate was determined by the hardness and flow in gallons per minute of the water. Quite often, however, these drips were poorly tended over an extended period of time and failed to bring about the results desired.

During the summer of 1946, experiments were started with copper-sulphate paints. The Navy was successful in the development of antifouling paints for sea-faring vessels during the war. These paints, applied to the hulls of vessels, prevented barnacles, teredos, and many other marine

growths from attaching themselves to the ships for considerable lengths of time. Even though we know of no recorded instances, ships free of fouling organisms probably had a decided advantage in speed for either combat or escape from the enemy. Since the paints used contained varying percentages of copper sulphate and fresh-water studies have shown that algae belonging to the blue-green and green groups are adversely affected by the chemical, it was hoped that the paints could be used in the control of these algae.

Local paint concerns were contacted in an effort to obtain copper paints of the type used by the Navy, and one manufacturer was able to supply the desired product. Paint could be obtained in red, brown, or green. A gallon of brown copper yacht paint was purchased at a cost of \$4.50.

Two circular ponds, 22 feet in diameter, located at the Nevin Hatchery, Madison, Wisconsin, were thoroughly scrubbed and cleaned for the experiment. On October 31, 1946, Pond A was painted with 1/2 gallon of copper yacht paint. Only one coat, thoroughly brushed in and distributed, was applied. Pond B, unpainted, was used for a control. The paint was permitted to dry in Pond A for 12 hours. In accordance with the manufacturer's directions, the paint was not



Pond A, painted with brown copper yacht paint that controlled algal growths effectively.

Pond B, showing the thickness of algal growths after 25 days.



allowed to become so dry that the poisonous principle in the paint would be sealed in the paint film too thoroughly to be effective.

After 24 hours, 5,000 rainbow trout, averaging from 4 to 6 inches in length, were introduced into both ponds. Algal growths completely covered the bottom of Pond B within 10 days. After every 25 days, it was necessary to scrub this pond because of algal growths of 1/2 inch or more in thickness. Pond A remained virtually clean until the termination of the experiment on April 2, 1947.

The fish in both ponds appeared to grow equally well. Losses were comparable in these ponds. The paint did not seem deleterious to the fish but controlled the algae effectively. We believe a great deal of time and expense can be saved by the use of this paint for algae control.

For convenience of readers, the Fish Management Division of the Wisconsin Conservation Department has supplied the names and addresses of the following sources of paint:

Pettit Paint Company
Belleville, New Jersey

Metallic Coatings Corporation
234 West 44th Street
New York 18, New York.

The Fish and Wildlife Service offers neither recommendation nor endorsement of any commercial product.

IT'S MUTUAL

There is quite a population of snails in the rearing ponds for northern pike at the U. S. Fish-Cultural Station at Valley City, North Dakota. From Mr. C. E. Cozort comes news of an infrequently reported observation. The small pike (up to 3 inches) snatches at the meaty part

of the feeding snail. The snail immediately withdraws into his shell, pulling in the northern pike before he can let go. The snail, of course, cannot swallow the northern pike; his teeth keep the pike from releasing himself; and both the fish and the snail die.

RELATING TO PUBLICATIONS

SELECTED BIBLIOGRAPHY OF NORTH AMERICAN

FRESH-WATER FISHERY BIOLOGY, 1941-1946

Karl F. Lagler and Charles K. Fisher, Jr.
University of Michigan
Ann Arbor, Michigan.

IN ORDER TO facilitate research and study in fresh-water fishery biology, we have searched for pertinent papers in a number of journals which carry fishery articles. Our findings are here presented under major subject headings, without other information as to content and without cross references. The period covered approximates that of the last war (roughly 1941-46), as workers who were away on service duty would benefit most by such coverage. It is hoped that this bibliography will help bring up to date the reader's information on scattered studies and will give him fundamental knowledge of modern trends in fishery research and management. The section of the PROGRESSIVE FISH-CULTURIST on recent literature will be helpful in keeping one abreast of this field.

It is assumed that all fishery personnel subscribe to or receive the following publications (back numbers are also available); we have therefore not listed titles appearing in these:

- (1) TRANSACTIONS OF THE AMERICAN FISHERIES SOCIETY.
\$3.00 per year; Dr. R. P. Hunter,

Preparation of this bibliography was conducted under the auspices of the Trust Fund for Fishery Research of the Associated Fishing Tackle Manufacturers and the Department of Zoology, University of Michigan.

Secretary-Treasurer, American Fisheries Society, P. O. Box 1495, Hartford, Conn.

- (2) COPEIA.
\$3.00 per year; Dr. M. G. Netting, American Society of Ichthyologists and Herpetologists, Carnegie Museum, Pittsburgh, Pa.
- (3) TRANSACTIONS OF THE NORTH AMERICAN WILDLIFE CONFERENCE.
\$1.00 to \$2.00 per annual issue; Wildlife Management Institute, Investment Building, Washington, D. C.
- (4) FISH AND WILDLIFE SERVICE, U. S. DEPARTMENT OF THE INTERIOR.
Publications on fishes (available gratis to qualified workers), including PROGRESSIVE FISH-CULTURIST and WILDLIFE REVIEW; Fish and Wildlife Service, Merchandise Mart, Chicago 54, Ill.

It is impossible to list papers from various State conservation bulletins and magazines or to record papers from many other sources and journals because of the large volume of this material. However, the authors and the Trust Fund will provide reasonable searching service for the same period for other publications on request from research workers who do not have ready access to library facilities.

In all, the present selection of references includes some 275 titles culled from 18 periodicals. We have omitted taxonomic papers and some others of a theoretical nature but have attempted to include all articles germane to freshwater fish management. A list of the journals, the abbreviations used to identify them, and the portions of each covered by the subsequent bibliography, follows:

- Amer. Mid. Nat., Vols. 25-35, inc.
American Midland Naturalist,
Notre Dame, Ind.
- Bull. Ill. Nat. Hist. Surv., Vols. 22-23, inc.
Bulletin of the Illinois Natural History Survey,
Urbana, Ill.
- Calif. Fish and Game, Vols. 27-32, inc.
California Fish and Game,
Ferry Building,
San Francisco 11, Calif.
- Calif. Fish Bull., Nos. 57-64, inc.
California Fish Bulletin,
California Div'n of Fish and Game,
Sacramento, Calif.
- Ecol., Vols. 22-27, inc.
Ecology,
Brooklyn Botanic Garden,
Brooklyn, N. Y.
- Ecol. Monog., Vols. 11-16, inc.
Ecological Monographs,
Duke University,
Durham, N. C.
- Invest. Ind. Lakes and Streams, Vol. 2-Vol. 3, No. 2, inc.
Investigations of Indiana Lakes and Streams,
Indiana Department of Conservation,
Indianapolis, Ind.
- Journ. Fish. Res. Bd. Canada, Vol. 5-Vol. 6, No. 6, inc.
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REPRINT

PROPAGATION OF CATFISH

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Artificial propagation of channel and blue catfish has been studied and practiced for many years at the Gretna State Fish Hatchery. Our experiments have proven successful. Pondfish cultural practice is followed until the eggs have been deposited. Earth ponds are used for holding catfish spawners. Brood ponds are left dry during the winter so the pond can be cleansed by the sun, wind, and freezing throughout the winter. In the spring, nests are placed along the embankment and shallow parts of the ponds, preferably ten feet apart. Earthware crocks ten inches in diameter and two feet long have been used. It was found, however, through experiment, that empty nail kegs placed on their sides were more satisfactory and less expensive. Two inches of concrete placed in the bottom side of the keg will keep it from floating. A wire handle attached to reach above the water enables one to raise the nests while collecting eggs. About two quarts of sand are placed in each keg; the sand aids the male fish in cleaning the keg of sediment in preparation for receiving the eggs, and also prevents the eggs from clinging to the concrete bottom. When the water temperature rises to about seventy degrees, the ponds are filled with river water, the natural water environment for this kind of fish.

We have learned that fresh-trapped spawners give us better results than brood stock held over from year to year. After the brood fish have spawned, they are

stocked in suitable streams in the state and replaced the following spring by fish trapped from the Missouri River. Apparently the held-over spawners do not find hatchery pond environment suitable to producing an abundance of fertile eggs.

The catfish is normally a fish preferring running water. It has been found essential to exercise the brood fish even after introducing them into brood ponds. To condition them for spawning, a current of river water is pumped through the ponds during breeding time. The brood fish are carefully selected. Smooth, oily looking fish of good health, and weighing from two to ten pounds are selected, and are well fed up to spawning time.

To prevent the presence of infertile fish among the brooders, and to insure an equal number of males and females, it is necessary to inspect each prospective brooder to determine sex and fecundity. This is done by a careful examination of the reproductive openings.

During mating time the fish carry on a courtship wherein the male stays close to the female. This activity may last for one or two weeks after the spawners are placed in the ponds. All through this period, however, the male carries on his work of cleaning the keg. Occasionally he seems to invite the female to inspect the nest. When the female finally approves the cleanliness of the nest, she swims out of the keg, rises lightly to the top of the water, fills herself with air, then swims back into the keg. She inhales the air in order to be able to exert pressure during the passage of her eggs. The male, using his teeth, breaks the gelatin in the reproductive vent of

the female. She then begins the passage of her eggs. When she has passed a layer of eggs inside the keg, the male pushes her aside and begins the process of fertilization by depositing sperm over the eggs. When he has fertilized the first layer, the female returns and deposits another layer. This process is repeated until the female has laid all her eggs. As the eggs are deposited and impregnated with sperm, they form an oval glutinous mass, adhering to each other and to the sand in the bottom of the keg. The eggs are of a golden color. After the female has finished laying her spawn the male becomes the sole protector of the nest. He does not even permit the female to re-enter the keg where he is tending the spawn by "fanning" the eggs and circulating the water. These eggs will hatch in the keg, but not as efficiently as by our artificial propagation method.

In artificial propagation, catfish spawn is collected twice daily, at eight o'clock in the morning and at four in the afternoon. Most of the spawn is obtained in the morning. The removal of the eggs may be accomplished by raising the top of the keg to the surface of the water, then gently releasing the egg mass from the sand by inserting the fingers through the lower side of the keg. The egg mass is transferred into a large pan of water at pond temperature. This transfer must be made with the greatest care to expose the eggs to as little air and sunlight as possible. These masses of eggs are immediately taken to the hatching troughs where they are slowly tempered-in to the temperature of river water. River water is essential to successful hatching, but usually differs slightly in temperature from pond water. We get best results in water of a temperature of seventy-five to eighty degrees Fahrenheit.

Our hatching battery consists of two troughs, ten inches wide, ten inches deep, and sixteen feet long, set six inches apart. Paddles are set in the troughs, sixteen inches apart. Then a screen basket, into which the eggs are placed, is hung between each two paddles so that the bottom of the basket is about two inches above the bottom of the trough. The paddles oscillate slowly back and forth, thus fanning the eggs, aerating and cir-

culating the water. With a current of water running through the troughs, this agitation simulates the activities of the male on the nest. Then the masses of eggs are gradually brought to the right temperature. As the eggs hatch, the fry work through the screen basket to the bottom of the trough, leaving the adhering matrix in the basket to be thrown out. The average weight of a spawn is about nine ounces. The eggs run about seven hundred per ounce. If any infertile eggs appear in the spawn during the hatching period, they are picked off daily with tweezers. The eggs hatch in from seven to nine days at eighty degrees temperature. On about the fifth day, the eggs show little black specks. This is called the eye stage. In another two or three days the eggs hatch into golden-colored fry with a yolk sac which clings to them for three more days. When the yolk sac begins to disappear, the fry may be transferred to the feeding troughs and are ready to be fed.

The catfish fry are best reared in troughs because of the necessity for protection and cleanliness. As they grow, their golden color changes to cream, then to the final grayish-blue within two weeks time. The fry have barbs from birth, sharp as needles. Therefore, they should not be bunched closely together as their barbs can easily pierce the skin of the other fish. The fry are transferred to feeding troughs by rubber or glass tubes and dipped up by a small dip net covered with fine netting. The troughs and fish are kept scrupulously clean.

The fry are fed twice daily and the unconsumed food on the bottom of the trough is siphoned off once daily. No food should be allowed to collect on the bottom of troughs. All excess is removed frequently enough to prevent the water from becoming polluted. Food consists of beef livers and melts, dried skim milk, white fish meal, cottonseed meal, and wheat flour middlings. Food must be ground fine enough for fish to take readily, then screened and passed through a colander. The food is ground according to the size of the fish and as they grow older their diet is gradually changed. This change is from seventy-five percent meat and twenty-five percent cereal at

the fry size, to twenty-five percent meat and seventy-five percent cereals at fingerling size.

Catfish fry are reared in feeding troughs where an abundance of river water is available. Careful consideration of the amount of water running to each trough has to be taken to exercise and aerate the fish. Troughs provide an ideal means of hatching eggs and holding the fry, but after the fish begin feeding, other factors must be taken into consideration. In the first place, the rapidly growing fish constantly require additional space if they are to be kept in vigorous condition. The number of fish that can be held in a trough without detriment to their growth or health will depend, of course, primarily on their size and on the volume and temperature of the water.

At the age of six weeks the young fish are transferred from troughs to screen holding-pens in the rearing ponds. These pens are six feet long, four feet wide, and three feet deep, and made of one-eighth inch wire mesh. They hold from ten to fifteen thousand fish which are confined for four weeks, with a current of river water running directly into each pen. Feeding is carried on in the same manner as in the troughs. When the fish are ten weeks old, each rearing pond is cleaned thoroughly and left to dry a few days before refilling with water. From then on the catfish are given free range of the rearing ponds. It is necessary to inspect the ponds frequently for cleanliness and enemies of the young fish. Enemies are: crayfish, turtles, snakes, water tiger beetles, and the dragon fly. By holding the fish from fry to fingerling stage in troughs and pens, it gets them through the most critical stage of their life, protected until they are able to keep away from their enemies. The dragon fly will kill young catfish up to two inches long, eating them all but the head. The water tiger beetle paralyzes the young fish by stinging them, then sucks the juice or life out of the fish. The crayfish lies in his hole waiting for the fish to come in, then catches and eats them. Since using these holding-pens for rearing catfish fry to the ten week stage, protected from enemies, we have increased production about ten percent. I have collected as much as one gallon

of dragon flies and water tiger beetles in cleaning one eighty by eighty foot pond. When these enemies are present in the rearing ponds they will destroy an average of five fish per day each.

Careful examination of the fish is made to guard against diseases, since catfish seem more susceptible than many other fish to what is commonly called white spot and gill disease. Whenever the catfish suddenly stop taking food, and show loss of pep, they are examined at once for the possible presence of gill disease. If this parasite is present, the gills will be swollen, coated with mucus, and have a deeper red color than usual. On the first appearance of this disease, the fish are dipped in one of the following solutions: 1:2,000 solution of copper sulphate, a five percent alum sulphate solution, or a four percent vinegar and one percent salt solution. The vinegar and salt solutions give us very good results and are very economical. In the early stages of white spot disease, the infected catfish usually rub against the sides and bottom of troughs. In late stages the fish become sluggish and lie around the edges of the pond. By examining the fish we find small, grayish-white swellings or elevations on the body and fins. The catfish should be dipped in one of the following solutions: 1:500 solution of acetic acid, 1:4,000 solution formalin, or a three percent salt solution. A few of the parasites usually survive, so the treatment must be repeated at frequent intervals until the disease is under control. Removing the fish from ponds, then cleaning the ponds thoroughly, is a very good preventive measure. It is necessary to use river water in troughs and rearing ponds. By this practice we are very seldom annoyed with white spot disease. But as soon as we divert any spring water to where we rear catfish, this disease breaks out immediately.

Propagation of blue catfish is the same as that of channel catfish. The blue catfish are, however, more easily frightened and are more suspicious of new surroundings. In contrast with the channel catfish, the blue catfish prefer to spawn in nests hidden in the banks of the pond rather than in nail kegs.

ABSTRACTS

UTILIZATION OF THE SAUGER CROP IN NORRIS RESERVOIR, TENNESSEE. R. W. Eschmeyer and O. F. Haslbauer. Jour. Tenn. Acad. Sci. 21 (1): 72-75 (1946).--The crop of sauger in this reservoir is largely wasted; most individuals die of old age. These fish could be harvested in winter by use of gill nets, and few other fish would be taken. Winter netting for sauger under close supervision deserves serious consideration.

SPRING FISHING ON SEVERAL T.V.A. STORAGE RESERVOIRS, 1945. R. W. Eschmeyer, D. E. Manges, and O. F. Haslbauer. Jour. Tenn. Acad. Sci. 21 (1): 78-88 (1945).--The catch on Norris reservoir in April-June was estimated at 264,100 pounds. Evidence indicated that in spite of opening the reservoirs to year-round fishing, most bass still are uncaught and die from natural causes.

DISCUSSION OF THE RESULTS OBTAINED FROM INVESTIGATIONS ON THE FOOD AND GROWTH OF BROWN TROUT (Salmo trutta L.) IN ALKALINE AND ACID WATERS. W. E. Frost. Proc. Roy. Irish Acad. Sec. B, 50 (19): 321-342 (1945).--In Ireland, slow-growing trout are found in acid waters and quick-growing trout are found in alkaline waters that contain lime.

WINTER FEEDING HABITS OF BLUEGILL, Lepomis macrochirus Rafinesque, AND YELLOW PERCH, Perca flavescens (Mitchill), IN CEDAR LAKE, WASHTENAW COUNTY, MICHIGAN. J. W. Moffett and B. P. Hunt. Trans. Am. Fish. Soc. 73: 231-242 (1943).--Bluegills consumed aquatic insects in early and late winter and plankton in midwinter. Yellow perch fed on small bluegills and ostracods in midwinter.

FURTHER STUDIES ON THE INCREASED GROWTH RATE OF ROCK BASS (Ambloplites rupestris Rafinesque) FOLLOWING THE REDUCTION IN DENSITY OF THE POPULATION. W. C. Beckman. Trans. Am. Fish. Soc. 72: 72-78 (1942).--Poisoning of fish in a portion of Booth Lake resulted in increased growth of rock bass. This appears to be one solution for lakes with stunted populations.

THE ANAESTHESIA OF FISH BY HIGH CARBON-DIOXIDE CONCENTRATIONS. F. F. Fish. Trans. Am. Fish. Soc. 72: 25-29 (1942).--A practical and economical method for anaesthetizing adult salmon and steelhead trout in fish trucks is described. The method consists of generating a predetermined CO₂ concentration in the 1,000-gallon tanks by addition of predissolved NaHCO₃ and dilute H₂SO₄ in proper quantities.

BAIT MINNOW PRODUCTION IN PONDS. A. C. Bauman. Mo. Conserv. 7 (6): 3-5 (1946).--Ponds must be deep enough to prevent winter kill. Blackhead (Pimephales) and golden shiner (Notemigonus) minnows are recommended. Blackheads are stocked at rate of 300 adults per acre and produce 85,000 bait-size minnows yearly. Golden shiners stocked at 100 per acre produce 6,000 to 50,000 minnows per year. Growth can be speeded up by fertilizing weekly with 100 pounds to the acre of 4-12-4, till 1 ton to the acre is reached. Addition of lime up to half the weight of the fertilizer is beneficial.

NOTES ON THE EFFECT OF CAUTERIZATION IN FIN-CLIPPED TROUT. E. F. Herman. Copeia 1946 (2): 96 (1946).--Cauterization of clipped fins prevented fin regeneration in 98 percent of fish.

NUTRITIVE VALUE OF FISH FROM MICHIGAN WATERS. I. NICOTINIC ACID OF LAKE HERRING, CARP, COMMON SUCKERS, AND BURBOT. J. F. Klocke, Thelma Porter, P. I. Tack, Edna Leffler, N. S. Henry, and Ruth Nitchak. Food Res. 11 (2): 179-186 (1946).--Lake herring contained 23 to 55 gamma of nicotinic acid per gram of edible tissue; common suckers, 11 to 13 gamma; carp, 15 gamma; and burbot, 16 gamma. An average serving of lake fish furnished one-tenth of the daily nicotinic acid requirements of an average man.

THE RELATIONSHIP BETWEEN THE PRODUCTION OF FISH AND THE CARBON AND NITROGEN CONTENTS OF FERTILIZED PONDS. O. L. Meehan and Francis Marzulli. Trans. Am. Fish. Soc. 73: 262-275 (1943).--In hatchery ponds there was an inverse relationship between production in pounds of fish per acre per day and humus in the pond bottom as well as the amount of organic matter and total nitrogen in the water. A positive correlation occurred between fish production and the carbon/nitrogen ratio in the pond bottom after fertilization was stopped.

FISH PRODUCTION IN LAKES AS A GUIDE FOR ESTIMATING PRODUCTION IN PROPOSED RESERVOIRS. G. A. Rounsefell. Copeia 1946 (1): 29-40 (1946).--A linear regression was fitted between lake area and total population and annual sport and commercial yields of fish in 100 lakes and ponds. This is useful in predicting the yield of fish in future reservoirs and in indicating the relative decrease in abundance as the lake area increases.

RECAPTURES OF TAGGED WALLEYES, *Stizostedion v. vitreum* (Mitchill), IN HOUGHTON LAKE AND THE MUSKEGON RIVER, ROSCOMMON COUNTY, MICHIGAN. W. F. Carbine and V. C. Applegate. Copeia 1946 (2): 97-100 (1946).--About 19 percent of the 100 tagged walleyes were recovered in the succeeding 3 years by anglers. This shows a high rate of removal by fishermen.

EFFECTS OF D.D.T. ON FISH. E. W. Surber. Jour. Wildlife Mgt. 10 (3): 183-191 (1946).--Emulsions of D.D.T. were more toxic than suspensions. Aerial spraying of streams with applications containing as little as 1 pound of D.D.T. per acre killed some fish.

AN EXPERIMENT IN THE USE OF DERRIS ROOT (ROTENONE) ON THE FISH AND FISH-FOOD ORGANISMS OF THIRD SISTER LAKE. C. J. D. Brown and R. C. Ball. Trans. Am. Fish. Soc. 72: 267-284 (1942).--Derris root (5-percent rotenone) was used at the rate of 0.5 p.p.m. A second application of slightly greater strength was necessary to kill all the fish. Not all fish came to the surface after death. Surface waters remained toxic 7 days. The toxicity of the lake water decreased with depth. *Corethra*, *Daphnia*, *Diaptomus*, and most zooplankton were greatly reduced. Phytoplankton were not affected. Tadpoles, leeches, and dragonflies were drastically reduced.

WARM-WATER FISH MANAGEMENT. A. S. Hazzard. Wis. Cons. Bull. 10 (10): 12-15 (1945).--"Stunted" fish are retarded in growth because of lack of food, but they will grow if transferred to waters that contain plenty of suitable food.

PARASITES OF NORTHERN WISCONSIN FISH. R. V. Bangham. Trans. Wis. Acad. Sci., Arts, and Letters 36: 291-325 (1944).--Lists the species of fish and the parasites found. Of 1,330 fish examined, 93 percent were parasitized mainly by encysted strigeids, encysted eye flukes, and gill flukes.

HOW TO MARK FISH. G. A. Rounsefell and J. L. Kask. Trans. Am. Fish. Soc. 73: 320-363 (1943).--The origin, use, and development of tags in common use are discussed. A summary of tagging experiments is given.

TOXICITY TO RAINBOW TROUT AND MINNOWS OF SOME SUBSTANCES KNOWN TO BE PRESENT IN WASTE WATER DISCHARGED TO RIVERS. J. Grindley. Ann. Appl. Biol. 33 (1): 103-112 (1946).--Toxicity (to fish) of several pure substances was measured under controlled conditions. The materials tested were sodium arsenite, sodium arsenate, sodium picrate, sodium dinitrophenate, zinc sulfate, potassium chromate, potassium dichromate, ammonium chloride, and ammonium sulfate. The arsenite was more toxic than the arsenate. Solutions containing 20 p.p.m. arsenic were toxic to minnows. Zinc-sulfate solutions containing 25 p.p.m. zinc were toxic to rainbow trout. The dichromate was more toxic than the chromate. Solutions of 20 p.p.m. chromium were toxic to rainbow. Solutions of ammonium sulfate or chloride were equally toxic, those containing 100 p.p.m. NH_3 being toxic in distilled water, and those containing 50 p.p.m. being toxic to trout in moderately hard water (26 p.p.m. CaCO_3).

A PRELIMINARY REPORT ON THE FISHERY OF MILLERTON LAKE, CALIFORNIA. W. A. Dill. Calif. Fish and Game 32 (2): 49-70 (1946).--Millerton Lake is a 4,900-acre warm-water reservoir subject to an annual vertical fluctuation of at least 100 feet. After 2 years of stocking, the lake was good for fishing. The catch was 162,166 sport fish--bluegills, 80 percent; large-mouth bass, 12 percent; green sunfish, 8 percent; rainbow trout, 0.06 percent.

THE BIOLOGY OF LAKE BOWER RESERVOIR DURING THE PERIOD OF ITS FIRST FILLING, APRIL, 1943 TO DECEMBER, 1944. R. W. S. Thompson. Water and Water Engineer 49 (604): 331-348 (1946).--A complete study was made of the biological chemistry and the physical changes occurring in the reservoir. Figures on phytoplankton showed that they were not sufficiently abundant to provide food for the animals present. Cladocera and other organisms were feeding on bacteria and detritus. The flooded vegetation decayed and furnished food for aquatic insects and zooplankton.

RECEIVED IN CLEARING HOUSE

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U. S. Dept. Agr. Farm. Bull. 1983, 29 pp., illus. March 1947.
(Available from Office of Information, U. S. Department of Agriculture, Washington 25, D. C.)
- Mistakes versus essentials of pond management for fish. Verne E. Davison. Reprint from Better Crops with Plant Food Magazine.
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- Food of killifish and white perch in relation to supply. M. W. Smith.
Jour. Fish. Res. Bd. Canada, 7 (1): 22-34. 1947.
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- Heat transfer in trawler holds. A. F. Dunn.
- The yield of native and planted trout to anglers from Charlotte County Lakes, New Brunswick. M. W. Smith.
- Efficacité d'un nouveau modèle de table de tranchage. H. Fougère and A. Nadeau.
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- Keeping quality of smoked fillets. E. P. Linton and W. J. Dyer.
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